THE

NEW SCIENCE REVIEW

A Miscellany of Modern Thought and Discovery.

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VOL. II. OCTOBER, 1895. No. 2.

THE FORMATION OF COAL.

BY HOMER GREENE.

Geology is one of the most fascinating of the sciences, and of its subdivisions that one pertaining to the formation of coal is, doubtless, the most interesting.

Investigation in this particular field of geological study has been by no means exhaustive, but enough has been learned concerning the formation of mineral coal to permit us to sketch, with some degree of accuracy, its origin and development. That it is a product of vegetation there can be no longer any reasonable doubt. There are many facts which tend to make this theory conclusive. In the first place, carbon is the principal element in the composition of coal. A good specimen of hard-dry anthracite would show from ninety-one to ninety-eight per cent. of carbon. The average anthracite of commerce, known technically as semi-anthracite, would show from eighty-five to ninety per cent., and the bituminous and semi-bituminous varieties would range all the way from fifty to eighty-five per cent. The amount of volatile matter contained increases from three per cent. in the anthracites to thirty-eight per cent. in the bituminous species. The conduct of these different kinds of coal in combustion gives practical emphasis to the difference in composition. The anthracites burn with a small blue flame of carbonic oxide until thoroughly ignited, give off no smoke and leave a comparatively small percentage of ashes. The

bituminous classes, on the other hand, burn with a continuous yellowish flame, give off considerable smoke and leave a large percentage of ashes.

These characteristics of coal are all important factors to be considered in passing upon the question of its origin.

But that coal is a vegetable product may be specifically proved. Indeed, ocular demonstration may be had of that fact. For while to the naked eye the structure of a fragment of mineral coal is purely amorphous, yet if that fragment be made so thin that it will transmit light, and if it be then examined through a powerful microscope, its vegetable structure will be readily distinguished. It is evident, however, that great forces must have been at work to obscure to such an extent all traces of vegetable formation. And great forces have been at work through many ages. Heat, pressure and confinement have produced the transformation.

If coal is a vegetable product these forces have increased its percentage of carbon from the amount contained in woody fibre, which is from twenty to twenty-five per cent., to the amount already shown to be contained in coal. There is, however, nothing strange about this; wood is so transformed into charcoal, a substance which contains ninety-eight per cent. of carbon. It is simply a matter of combustion; but not of combustion in the open air, for then the carbon of the wood would escape into the atmosphere. It must be a process of smothered combustion. The carbon must have no opportunity to unite with the atmospheric oxygen. It will then be retained; the volatile matter will be freed and expelled; a small percentage of ash will be left, and the transformation from wood to charcoal will be complete. This is the artificial process of making coal. The natural process is similar. The operation may be watched in any peat bog. A peat bed is simply an accumulation of the remains of plants which have grown and decayed, and have been year by year buried more deeply under succeeding growths. Remove the upper layer and you find peat with its fifty-two to sixty-six per cent. of carbon. The deeper you go, that is, the older and longer buried the product,

the better will be its quality for fuel. If this process of deposition should continue through many geologic ages the result would doubtless be true coal. Indeed, we have but to go back to the glacial epoch, or first period in the age of man, to find the first formations of lignite or brown coal. Here the woody fibre that has been buried is soft and brown, and can be cut like soap. Going back to the Miocene strata, or the second period of the mammalian age, we find that the wood has become black, and when we reach the upper Cretacious, or last period in the age of reptiles, it is also hard and compact, though still showing its woody structure and taking therefrom its name of lignite.

The question now is whether the conditions that surrounded the formation of coal in the Carboniferous age were similar to those under which we make charcoal to-day, and those under which the beds of peat and lignite have been formed in recent periods.

There are certain facts concerning the Carboniferous age which have been pretty thoroughly demonstrated by the science of geology. It is known that at that time the area now covered by the Middle, Southern and Western States was little more than a vast marsh burdened with the most luxuriant vegetation. The conditions were all favorable for the rapid and enormous growth of plants. The soil was rich and moist. The heat was greater than exists to-day at the torrid zone. The internal fires of the earth had not so far receded. The sun was larger and more powerful than it now is. The humidity of the atmosphere was great and constant. The air was laden with carbon. Man, who is eminently an oxygen-breathing animal, could not have existed in such an atmosphere, while plants, the principal food of which is carbon, luxuriated in it. They grew to enormous sizes. Plants which in our day are mere stems, a fraction of an inch in diameter, were in that time represented by trees from one to three feet in diameter and from forty to one hundred feet in height. Ferns grew in great abundance. The rocks of the coal-bearing strata are filled with their fossil remains. The Lepidodendrids, the Sigillariæ and the Conifers were

great forest trees covering large areas, while the Calamites, growing up with long reed-like articulated stems to a height of twenty feet or more, stood so close together in the muddy ground as to form an almost impenetrable thicket. This last species probably made up a very large percentage of the vegetation which was transformed into coal. This mass of vegetation, including more than five hundred different species, was constantly growing, falling and decaying. Year after year, century after century, this process continued until these beds of decayed and decaying wood and vegetable matter reached an enormous thickness, each succeeding growth forming a still richer bed for the vegetation to follow.

If the theory propounded by Laplace is correct our earth was at one time a ball of liquid fire.

Cooling and condensation progressed from the surface toward the centre. Contraction of the earth's crust necessarily followed, and vast areas of land sank and were covered by the waters. This process was still going on during the Carboniferous age. The submergence of a bed of this incipient coal meant the cessation, for a time, of vegetable growth from its surface. That surface was covered instead by the sand, mud and gravel washed over it by the waves, by the drift from higher levels, and by the limestone deposits swept up to it from the sea. When contraction ceased for a time, and the earth's crust again became stable, the waters began to recede, leaving behind them great wastes of mud and sand. And, following this slow recession to the sea, vegetation crept once more over the surface of the land, the soil grew rich with the products of decay, and plant life reigned and rioted anew. But cooling and contraction of the earth's body were going continuously on, and submergence followed again and again, each bed of vegetable matter, thick or shallow, being covered in turn by its layers of sand and silt.

These movements in the earth's crust were not sudden nor violent. A single foot would, doubtless, mark the subsidence for a century. A rough estimate of the time during which these deposits were being laid down can be formed from the fact that the carboniferous measures alone in Penn-

sylvania and Virginia show a sinking of three thousand or four thousand feet, while the entire subsidence of the earth's crust up to the close of the Carboniferous age amounted to only thirty-five thousand or forty thousand feet.

In this submergence and burial of the deposits of the coal era we find all the conditions necessary for the transformation of vegetable matter into coal. Atmospheric air was excluded, the beds were subjected to enormous pressure, and heat was spontaneously generated. Combustion was going on in much the same way that it goes on in the charcoal pit, and the result was similar.

Only from one-ninth to one-sixteenth of the mass of vegetable matter subjected to this heat and pressure was retained in the form of coal. This was largely carbon, the hydrogen and oxygen having been expelled. As we have already seen, the anthracite coal contains a much larger percentage of carbon than does the bituminous, and a much less quantity of volatile matter. It is hard and brittle, the average quality has a distinct metallic lustre, and it breaks into irregular pieces. Bituminous coal, on the other hand, has its regular planes of cleavage running at right angles with each other, and breaking up, uniformly, into cubical fragments. It is dead black, without lustre, is so soft as to crumble easily with handling, and in combustion it swells, fuses and runs together in large porous masses.

Of the immense coal areas in the United States only an extremely small percentage are of the anthracite variety, and these all lie in the State of Pennsylvania, east of the Allegheny mountains, with the exception of a small field in Rhode Island. In detecting the causes of the differences between the anthracite and bituminous varieties of coal, the question of locality is, therefore, a most important factor. It is not thought that the vegetable life which entered into one class differed in any material respect from that which entered into the other. Indeed, the fossil remains in the coal measures, regardless of the variety of coal, are similar in nearly all respects. Geology again solves the problem. At the close of the Carboniferous age great disturbances took

place in the earth's crust. One of the results of these disturbances was the upheaval of the great Appalachian range in North America. Mention has already been made of the reduction of the earth's bulk by the cooling of its internal fires and the contraction of its crust. This contraction necessarily resulted in irregularities of the earth's surface, and the earth's crust was necessarily lifted along the lines of least resistance. This crust being somewhat hard and unyielding was corrugated, flexed, broken, thrown into all positions, inclined at all angles with the horizon. During the Appalachian revolution the ranges and ridges that were thrown up were practically parallel to the line of the Atlantic coast, though irregular hills and valleys were formed, and spurs of the mountain ranges were sent out in various directions. Yet the disturbances of this period were neither sudden nor violent. While the rock strata show the effects of the application of a force so tremendous as to be almost incomprehensible to the human mind, yet the probability is that these changes were gradual, and took place only through long periods of time. The coal measures of Eastern Pennsylvania were involved in this Appalachian revolution, as were those of Rhode Island.

While, therefore, the bituminous coal strata west of the Alleghenies are approximately horizontal and regular, the dip seldom exceeding an angle of five degrees with the horizon, the coal beds east of the Alleghenies lie in folds or ridges seamed with fissures and faults, scarred with all kinds of irregularities, often dipping into the earth at an angle approaching the vertical. In Rhode Island the geologic disturbances have been much greater than in Pennsylvania. The coal strata are abruptly flexed, folded, broken and displaced. And here we find an anthracite so extremely hard, brittle and irregular that it can be mined with very little profit, while the rocks associated with the coal measures have been given a true metamorphic or crystalline structure.

The presumption, therefore, is natural, if not conclusive, that prior to the close of the Carboniferous age all the coal deposits had been bituminous in character, but that the

violent movements of the earth's crust at the time of the Appalachian revolution, the enormous pressure and intense heat, were sufficient to expel a large portion of the volatile matter from the bituminous coal beds, and otherwise change their character into what we now class as anthracite.

Finally, all the geological conditions as they exist in the coal measures to-day point unmistakably to the vegetable origin of coal and to its formation in the manner described. For instance, we have said that after each periodical subsidence of the earth's crust the decayed vegetable deposits were covered by layers of sand, silt, mud, gravel and clay. We therefore find, as we expect to find between the separate seams or veins of coal, rock strata of greater or less thickness. We also find immediately under each separate coal seam a stratum of what is known as fire-clay. It is hard or soft as it underlies the harder or softer varieties of coal. In the anthracite measures it is in the form of a slaty rock, known as slate or stone-coal or bony-coal. It clings firmly to the coal substance, and after the coal is mined and broken into marketable sizes these fragments of slate are picked from it by the deft fingers of boys, or separated by ingenious mechanical devices. This fire-clay or under-clay is always present, and is usually filled with the fossil impressions of roots, stems, twigs, etc.

A peculiar plant of the coal-making era, and one very abundant in growth, was the Stigmaria. It had on the surface a short, stout trunk, from which stems branched downward into the soil, and then trailed out through the mud and water to distances of twenty or thirty feet. The fire-clay is rich with the fossil remains of these stems. This fire-clay stratum, it will be readily seen, was the soil from which, after each subsidence and the recession of waters, the next new growth of vegetation sprang, to be buried in turn by more luxuriant succeeding growths. It may also be added that, in the slate strata immediately overlying each coal seam, it is common to find the impressions of twigs, nuts, seeds, leaves, the most delicate fern tracery, and the trunks of great trees mashed flat between the layers; while,

in the softer beds of cannel coal, whole trees have been found, roots, trunk, branches, leaves, seeds and all transformed into like material with that by which they were surrounded.

The under surfaces of the coal seams are no more even and regular than were the upper surfaces of sand and clay from which the first growth of vegetation sprang that entered into the composition of each seam. These surfaces were corrugated by the action of the waves. Mounds were washed up around and over objects lying in the sand; great ridges and hollows were formed by the currents of the ocean; the clay surface was pushed up unevenly by the strong growth of vegetation.

All these irregularities were preserved and are found in the under surface of every coal seam to-day. The upper surface and the body of the coal itself are also marked by ridges and hollows formed not only through the causes already mentioned, but also by the action of running streams cutting a way through the marshy soil to the sea.

These hollows and the beds of streams becoming in turn filled with sand and gravel, and being hardened into rock, formed what the miner of to-day calls *rolls*, *horses* or *horse-backs*, wherever he finds them in the mine. These rocky ridges and protuberances in the coal seams must not, however, be confounded with certain other rocky irregularities differently formed. One of the results of the violent disturbances of the earth's crust already noted was to leave great rents in it across the lines of strata. These rents are known geologically as *fissures*. They have faces which are either parallel or enclose a wedge-shaped cavity. Sometimes igneous rock from the molten mass below was forced up into these openings; sometimes the cavities were filled with drift and rock fragments from the surface. In either case the mass became hard and compact, but with a character materially different from the rock on either side, the formation of which was contemporaneous with that of the coal.

It may be added that not infrequently the strata on one side of a fissure would be pushed up above or depressed

below the strata on the other side, thus forming what is known as a *fault.* In some cases the faces of the fault are found to be smooth and regular, in other cases they appear to have been violently torn, broken and displaced. Happily, the vertical displacement in the faults found in the coal seams is seldom more than a few feet, and form no very serious problem for the consideration of the mining engineer.

The question may arise, why, if these coal beds are the product of vegetable matter deposited so far back in geologic time as the Carboniferous age, we should find them to-day so near the surface of the earth, and even cropping out to it as they frequently do. It must be remembered, however, that in the coal fields of the United States the carboniferous measures are the latest and highest geological formation. And where the disturbance of the earth's crust has been slight, as it has been generally in the bituminous regions, the coal will be found lying near the surface. This is also true in the northern anthracite coal district of Pennsylvania; but in the southern and middle districts, where the folds and flexures are more marked and abrupt, deep mining is the rule. It must also be remembered that, since the earth's crust was thrown up into folds and ridges and peaks, many thousands of centuries have passed by with their heat and cold, and their sun and rain. Disintegration and erosion have been constantly at work. The hills and mountains have been worn down until their height is but a fraction of what it was at the close of the Appalachian revolution. Their substance has been washed continuously to the valleys, and from the valleys to the sea. It can be readily understood how these peaks and ridges were worn down until the coal measures were reached, and how, through these softer strata, the work of decapitation went resistlessly on until it was as if nature had sliced off the tops of all these folds and ridges she had thrown up, exposing the edges of the coal strata in what we know as the *outcrop,* or wearing the measures down to a point below the coal seams altogether.

In the middle and southern anthracite regions, where the disturbances to the earth's crust were very great and where

the strata was thrown up into high steep ridges and peaks, leaving deep, narrow synclinal valleys, these valleys have been partly filled with eroded material from the hills and with drift of later periods, so that the synclical axes of the coal seams are often thousands of feet below the surface of the earth. And an imaginary projection upward of the decapitated anticlinal would frequently reveal an anticlinal axis thousands of feet above the surface.

Geologists have so completely mapped out the strata making up the earth's crust, that one of the best methods of detecting the presence of any particular stratum at a certain place is to examine the outcrop at that place, and find whether the rocks are such as are usually associated with the stratum desired. This method is largely used in prospecting for coal. For instance, the great Baltimore vein in the Wyoming coal field, a vein that is now exhausted, was usually overlaid with a coarse red sandstone.

In the anthracite regions generally, prior to the deposition of the vegetable matter which formed the coal product, a stratum of considerable thickness was laid up which consisted mainly of quartz pebbles, white and water-worn, held in a firm lead-colored cement. This material, hardened into rock, is found underlying the lowest coal seam in these regions. Being of a peculiar formation and remarkably hard and firm it is readily distinguished, and is considered one of the surest guides for a mining engineer. Below it coal is rarely found. Until it is reached the earth is full of possibilities. Beyond its outcrop it is seldom considered worth while to seek for carboniferous deposits.

While, as was said in the beginning of this article, there can be no longer any reasonable doubt as to the vegetable origin of coal, still the mind must exert itself to the utmost in order fully to realize through what vast periods of time the processes were continued by which the coal of to-day was formed. Still more difficult of comprehension is the fact of the enormous amount of vegetable matter which entered into the composition of these beds of coal.

In the Pottsville regions in Pennsylvania the average thickness of the combined anthracite coal seams is one hundred and twenty feet. In order to make up this quantity of resultant coal there must have been an average thickness of vegetable deposit amounting to at least twelve hundred feet.

Hardly less wonderful is the fact that mineral coal, although it has been in general use for heating purposes only during the present century, has been one of the greatest factors in the progress of civilization. And while modern science has invented other processes for the generation of heat, it is likely to be many years before any of them will wholly supplant coal.

DOMESTICATION OF ANIMALS.

By Calvin Dill Wilson.

"Many the forms of life,
Wondrous and strange to see—
* * * * *
And by his subtle arts
He holds in sway the beasts
That roam the fields, or tread the mountain's height;
And brings the binding yoke
Upon the neck of horse with shaggy mane,
Or bull on mountain crest
Untamable in strength." Sophocles. Antigone.

Few persons, perhaps, when looking upon the animals which man has subjugated, give any thought to the origin of these creatures, or to the wonderful process by which he has made them his servants, or to the far countries and strange surroundings from which they have been brought into our life. Yet the story in all its fullness is one of the most interesting and thrilling chapters in history. For there has been a long and careful selection by man among all the forms on earth of those that could be useful or trained to serve him. It is a story of great conflicts, often of terrible dangers, of the death of many men. The wild creatures have not yielded to the will of man without strug-

gle, without the resistance of tooth and claw. It is also a record of many failures, for man has attempted to tame many creatures without success. He has learned only by experiment, and the creatures whom he has succeeded in bending to his will are the few successful results of many trials.

We may suppose that he took the cubs of many beasts, rearing them with the expectation of softening their natures, only to find the savage disposition breaking out with growth. Almost the whole range of animal creation has been experimented with for subjects fit for domestication, while with a hiss or a growl the failure has turned and fled from the habitations of men. The farthest countries have been ransacked, amid all perils and hardships, that man might find creatures to do his bidding. Many of the most irreclaimably ferocious have been entirely extinguished, while others have been driven away from the neighborhood of man, as the lion, whose range was once vastly greater than now. Into remote places, into deserts and impenetrable forests, the creatures have been expelled that would not come and bow to man and do his will; and man has set up his habitations with the obedient of the creatures around him.

It is a marvelous thing that the small creature man has been able to magnetize the great masses of flesh and muscle, and to expel their will, and to project into them his will, and make them serve. There is a great deal of kindness in the story also, for man has loved the creatures he has subjugated and associated with him in his labors and his life; and they have loved him. Much of the most beautiful sentiment of the world has had for its source the relations of man and the animals which he has made his friends and servants.

The forms of animal life that have been obedient and useful are the ones man has kept alive and multiplied. Many species and genera have perished, but all that we know leads to the conclusion that no kind once domesticated has been allowed to perish; so the docile animals have the best of it, and inherit the earth, while their savage brethren have already gone to extinction, or are rapidly going, under the encroachments of population on their territory.

Whatever may be the full story of the subjugation of the animals, we know that one of the greatest and most important things man ever did for himself was to discover that he could tame, train and use certain species of them for his purposes. This was greater than the discovery of the use of natural forces—as water, wind, steam and electricity—because more necessary. The gulf was thereby bridged between the condition of the savage hunter who had no subsistence but the beasts he could slay in the chase, and the pastoral condition where his food and clothing were kept peacefully at his door.

The first idea that led to domestication was simply the chase for food. The second was to have food at hand without the chase. The third idea was to make the creatures serve in some capacity besides food, as to hunt and labor. The first domestication was, doubtless, that of the wounded and the young of the wild creatures, which were kept for a time with a view to future food. By finding some of these amenable to kindness, the hunters advanced to the idea of keeping them for longer periods, and at last permanently. They discovered that they could have food to kill at need, and that they could use the milk, hair or wool. The capture of a female with young, and the production of the young in captivity, would naturally lead to conclusions as to the advantages of having captives which would continue to reproduce their kind within the enclosures arranged for them by man.

The antiquity of domestication is shown by the fact that the lake-inhabitants of Switzerland had tamed the ox, swine, sheep and goat. The monuments of Egypt show many domestic breeds that closely resemble those still existing. At first man used only the flesh, skin and milk of certain animals. Afterward the cow became man's assistant in agriculture. It was not till much later that the horse took the place of the cow. At first the horse was used chiefly in riding and traveling, and afterward more and more in agriculture.

XUM

Already in the time when the book of Job was written, the difference between the natures of those animals which man could tame, and those that were irreclaimably wild, was appreciated. "Who hath sent out the wild ass free? or who hath loosed the bands of the wild ass? whose house I have made the wilderness and the barren lands his dwellings. He scorneth the multitude of the city, neither regardeth he the cry of the driver. The range of the mountains is his pasture, and he searcheth after every green thing. Will the unicorn be willing to serve thee, or abide by thy crib? Canst thou bind the unicorn with his band in the furrow? or will he harrow the valleys after thee?"

The advance from the idea of domesticating creatures only for food to that of making them perform labor, arose in some such way as by some adventurous man, while herding cattle, being attracted by the broad back of the ox to climb upon it and save his legs by riding to and from the pastures to the shelter for the night.

The process of domestication began very early, in times that are prehistoric. The bones of the dog of the Neolithic Age are found in the kitchen-middens of Denmark and Switzerland. Philology shows that horse, ass, ox, and sheep were used by the Aryans before their dispersion. It is probable that the dog, the domestication of which Cuvier calls "the completest, the most singular, and the most useful conquest of man," was the first. Buffon, who, however, declares that the domestication of the horse "was the noblest conquest ever made by man," says: "To keep himself in safety and to render himself master of the living universe it was necessary to begin by making himself friends among animals, in order to oppose them to each other. The first art, then, of mankind was the education of dogs, and the fruit of this art was the conquest and peaceable possession of the earth." If this view be correct, the first use man made of a tamed animal was to have it help him hunt other animals. Darwin justly disputed the assumption that "man has chosen for domestication animals and plants having an extraordinary inherent tendency to vary and likewise to withstand diverse

climates." He does not dispute that these capacities have added largely to the value of most of our domesticated productions, "but how," he says, "could a savage when he first tamed an animal possibly know whether it would vary in succeeding generations, and whether it would endure other climates? Has the little variability of the ass or the goose, or the small power of endurance of warmth by the reindeer, or of cold by the common camel, prevented their domestication?"

The Century Dictionary defines "Domesticate—to convert to domestic uses; to tame or bring under control or cultivation." "Domestic animals," says Chambers Encyclopædia, "are those which, in order to turn them to his use, man has tamed or reduced in a greater or less measure from their natural wildness, and which he makes the objects of his care, and in a living state his property. They belong mostly to the classes of mammals and birds. Of mammals they are mainly the quadrupeds, and mostly herbivorous, most of them ruminants. There are but two rodents, the rabbit and the guinea-pig. There are two carnivorous, the dog and the cat; partially the otter and the civet. Of the birds, the most important domestic species belong to the gallinaceous order, and to the family Anatidæ among the web-footed. To the former belong the common fowl, turkey, peacock, and game fowl. To the latter the goose, duck, and so forth. Of other birds few are domesticated, except some song birds, like the canary." It is not uninteresting to observe that man has been able to make both birds and beasts of prey his servants. Of the reptiles, a few have been tamed for the killing of flies, mice, and rats. As the waste places of the world become peopled, animals, already becoming scarce, may be advantageously domesticated on account of their fur or other products for which they are now pursued by the hunter. Some domestic animals are limited by the climate to particular countries, as the reindeer to the Arctic regions, the yak to the steep and snow-clad Himalayan, the llama and alpaca to the region of the Andes. Many circumstances point to the same Asiatic region as that in which the greater

number of domestic animals were domesticated, which is commonly regarded as the cradle of the arts and sciences, and even of the human race.

"The ancient annalists," says George P. Marsh, in his book on "Man and Nature," "have preserved to us fewer data respecting the introduction of domestic animals into new countries than respecting the introduction of domestic vegetables."

"Nature," says Buffon, "has bestowed on us the horse, the ox, the sheep, and all our other domestic animals to serve us, feed us, and clothe us, and she has besides other species in reserve which would be able to supply this defect, and which would only require us to subject them and make them useful to our wants. Man does not sufficiently know what nature can do, nor what can be done with her." Herodotus said of the Egyptians, "Their laws compel them to cherish animals; a certain number of men and women are appointed to this office, which is esteemed so honorable that it descends in succession from father to son. The number of domestic animals in Egypt is very great. In whatever family a cat by accident happens to die, every individual cuts off his eyebrows; but on the death of a dog they shave their heads and every part of their bodies."

As illustrating some of the uses of animals in the early stages of efforts at domestication, the following passage from Lucretius is interesting. "They tried bulls also in the business of war, and endeavored to impel fierce boars against the enemy. The Parthians, too, sent strong lions before them, with armed keepers and daring guides to govern them and hold them in chains. But such attempts were in vain; for the savage beasts, heated with tumultuous slaughter, and shaking their terrible manes on every side, disordered all troops without distinction. The bulls tossed their own people, and trampled them under foot; they gored with their horns the sides of the horses."

Eastern monarchs have always taken great delight in new and strange things and forms of life, as we see in the history of Solomon. Some of the stranger forms of domestication

are owing to the desire of their servants to gratify their caprices. We also owe something along this line to the habits of children, who are always trying to tame the creatures about them for pets.

The fate of the aborigines of America would have been very different, if they had cultivated to the full their opportunities for the domestication of animals. North America provided the bison, the elk or moose, reindeer, dog and turkey. Of these only the dog was in general use; the bison was tamed by only a few of the tribes; the turkeys were domesticated by the Mexicans only; the elk and reindeer were not tamed at all. Central and Southern Africa had the elephant, buffalo, gnu, and eland that might have been used. But the North American Indian and the negro do not seem to have had much capacity for domesticating animals.

In the vivaria or game parks of the later Romans, various wild animals, boars, stags, roe-deer and so forth were kept in a state of semi-domestication.

Various modes of domestication have been used. Training and taming by means of a hook in the nose is a very ancient custom; this is mentioned in the book of Job. Animals have been brought into a gentler frame of mind by castration. Nets were put over the yards of the Romans where ducks were kept; this was done also with the other birds. The simple idea of cutting one wing had not occurred to them. Plenty of food scattered about was also a means used to keep the creatures in the neighborhood where it was desired they should stay. Starvation has been resorted to generally. Almost the entire process of breaking in or training a wild elephant is that of starvation. When at last his spirit is completely broken and strength gone for the time being, he becomes amenable to discipline, as much so almost as one that has been in captivity for years. He then partakes with eagerness of the food and water which is brought him, accepting the same as a sort of peace-offering, and gradually becomes attached to the keeper who has charge of him, and with whose presence the creature associates the idea of relief and comfort. From this time forward firm-

ness and kindness complete the taming process. Whipping, of course, is an obvious means that has been used on many creatures to bring them into subjection. Falcons were tamed in a dark room with considerable intervals between meals. Orpheus is credited with having charmed beasts with music. It is possible that music has been used at times for this purpose. The voice of man, the eye, gesture and magnetism of man, power of will, undoubtedly have all been factors in the taming process.

Animals have been domesticated by man for the following purposes: food and clothing, labor, hunting, defense, and as scavengers, pets, ornaments and articles of commerce.

Much remains yet to be done in the way of domestication. Several valuable animals await complete taming.

FOUR-DIMENSIONAL SPACE.[1]

By Arthur E. Bostwick, Ph.D.

There are scientific men to-day who hold that there is no inherent absurdity in supposing that a hollow rubber ball with no opening in it may be turned inside out without breaking it; that a man may escape from a doorless and windowless room without passing through the walls; that a knot may be untied while the ends of the string are held, and that hosts of other apparently impossible things may be done. They do not affirm, to be sure, that a man may now do these things, but they say that he is prevented from doing them in some such way as a part of a machine is prevented from leaving the slot in which it slides.

The reasons they give for this belief are curious enough, and can be understood by first attending to a few well-known facts. If a point moves, it leaves behind it a line, as a sort of trail; the mark made by a moving pencil-point on paper is an example. If we take a broad pencil, however, and

[1] This paper in a measure repeats the arguments of "The Curvature of Space," in our July number. But the subject is here so well set forth that we have consented to give it this second exposition.

sharpen it to a ridge, representing a line, we shall have when we draw with it, not a line but a band—a geometrical surface. Likewise, if we move through the air a surface—a sheet of paper, for example—it would leave behind it, were the space colored or marked somehow, a solid colored space. Thus, as far as we have gone, the trail has always one more dimension than the thing that leaves it. A point has no dimensions at all, neither length, breadth nor thickness; its trail has length alone. A line has one dimension—length; its trail, a surface, has two—length and breadth. The trail of this surface has three—length, breadth and thickness. Here, however, we stop. The trail of a solid, as one may see by moving a box or a block of wood through the air, has no more dimensions than itself—mere length, breadth and thickness. Why is this?

The reason is simple enough. We did not examine the case thoroughly. The ridged pencil does not always mark a broad band. If the ridge is slid along in the direction of its own length it makes only a line. The sheet of paper will not always describe a solid space in the air. If it is slid along edgewise it will pass through a surface like itself, only more extended. The reason is that in both these cases every point on the body follows in the trail of the point just in front of it, while in the case first described every point struck out as it were for itself into a new dimension. Now when we move a cube about in the air, however we move it, no matter what direction we try, every point save those in the front rank will follow in the trail of some other; it is impossible to make them all start out for themselves in a new dimension. We have, in fact, used up all the dimensions at our disposal—length, breadth and thickness; what we want is a fourth dimension. That this does not exist, or seems not to exist, thus appears almost equivalent to the breaking down of a law of nature. The law is true up to a certain point, then it suddenly fails. What shall we say of this apparent failure?

Now it happens that just such apparent breakages or stoppages of natural law have frequently been observed, and

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they have been found in so many cases to be only apparent that scientific men have generally asserted the broad law that no such real abrupt stoppage is possible. This broader law they call the law of continuity, and they assert that it is the great foundation law of nature—the law controlling all other laws. Either they must be wrong, then, or this absence of a fourth dimension must be only apparent. Indeed, the law compels us to say that there must be also a fifth, a sixth, and so on to infinity. We cannot move in these higher dimensions—or rather, we never have been able to do so. But neither have we been able to reach the stars. The physical conditions of our existence bind us down to earth. In like manner these physical conditions confine us to three dimensions. This fact scientific men state by saying that our space is a tri-dimensional space. But rather than believe that the law of continuity is broken they prefer to think that it is a limited space.

If we ever should break the limits and be able to move in more than three dimensions, all the apparent absurdities set forth at the outset would become easy of accomplishment. This can be rigorously proved by algebra, and it can also be clearly understood, thus: All that prevents us from turning a closed hollow ball inside out is the fact that each of its points cannot strike out for themselves. By the laws of our space a solid body cannot move except every point trails behind some other, and thus, in the present case, a change of place between the outside and inside layers of the ball would be impossible. Similarly, a flat rubber ring cannot be turned inside out if you lay it on a table and stipulate that no part of it shall leave the table. But as soon as you remove this condition; as soon as you allow it to leave two dimensions and move out into a third, the task is simple. Any one can do it. The trouble with the ball is, then, that the similar condition restricting it to three dimensions is imposed by nature and has never yet been removed.

There are a few persons, scientists of the highest reputation, who have believed—I do not know whether they still believe it—that the condition, in one or two cases, has been

removed; enabling certain men to move out into the fourth dimension, and do wonderful things similar to those stated at the beginning of this article. These favored men were so-called mediums, and it has been pretty well established that their miraculous deeds were fraudulent—mere tricks of legerdemain or optical delusions. Their exposure has been thought by some persons, who do not understand the point at issue, to have disproved the theory that higher dimensions than the third exist. It has done nothing of the sort; it has simply shown that up to this time the physical conditions restricting us to three dimensions have not been removed. Neither have those that prevent us from going to Mars or Venus. Most people believe that neither one set of conditions nor the other will ever be removed. Perhaps they will, but that is now a matter for pure speculation. We can tell, however, a great deal better what would happen if the dimensional condition were removed than we can what we would see upon Mars or Venus; for the first is a matter of mathematics, the latter one of physical astronomy.

Some persons have amused themselves by supposing that the abode of departed spirits is on some distant planet. But it is a good deal more probable that when the spirit is released from the body it simply is freed from dimensional conditions. How much this would broaden its scope may be seen from attending to a few more simple facts.

If a man were limited to two dimensions instead of three—if, for instance, he lived on a sheet of paper as a picture does—he would know of nothing outside of that sheet. A race of men might live in every one of a pile of a million sheets of paper, and it would be physically impossible that they should ever communicate or even be aware of the possibility of each other's existence, though the distance separating any two would be less than the thousandth of an inch. So, three-dimensional universes may be packed closely together in four-dimensional space, and we may be surrounded—almost touched—by myriads of beings like ourselves, of whose existence we are unconscious and into whose sphere we cannot come. The removal of dimensional conditions would open

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all these to us. To one who believes in a future world, the certainty that there is space enough for universes upon universes, almost in touch with every point of our own space, is much more pleasing than the relegation of all departed spirits to a planet hundreds of millions of miles distant.

In fact, upon any one who reflects much on the subject, the conclusion must force itself with almost irresistible cogency that here must be the refuge from the materialism that is seeking to hem us in on every side. The materialistic arguments are sound so far as they go; in their own sphere they are convincing; yet they reckon entirely within the sphere of our own tri-dimensional universe. That there must be more than this is, as we have seen, an inevitable consequence of the great foundation law of that universe. It is not necessary here to point out in exactly what way this may be applied to explain the observed facts regarding spirit as opposed to matter; it is enough to show that here is a field so wide that its prospect almost takes one's breath away. So far as appears now it offers a complete escape, indeed, the only escape, from materialism as opposed to all that is higher, from realism as opposed to idealism, from unbelief as opposed to spiritual religion. That it has not been appreciated as such, and that it has been relegated on the one hand to students of pure mathematics and on the other to idle speculators and visionaries, is one of the most significant facts of our times. It shows that most of us are of the earth earthy, and that we do not care to escape from the mire.

Space of indefinite dimensions, what mathematicians call "*n*-dimensional" space, is not a mere figment of the mathematical imagination. Its existence, if not proved, is eminently probable; it rests on higher and more fundamental grounds than that of universal gravitation or the luminiferous ether, for it rests on the law of continuity itself. Other explanations might conceivably be found for the phenomena that have been explained by the theories of gravitation and undulation, and the law of continuity would not be touched;

but the rejection of higher dimensional space involves the rejection of that law.

Many years ago a Russian chemist took to classifying the elements. He found that they fell naturally into ranks and files; but here and there he found a gap. So confident was he that the great law of continuity could not be broken, that he asserted at once that these gaps would one day be filled, and he predicted the properties of the yet-to-be-discovered substances that should stand in the vacant places. Nothing like this had ever been ventured before. Some stared; others smiled and murmured "perhaps." But to-day the ranks are filling up. Element after element has slipped into the gaps, each fitting into its proper place and possessing every property predicted by its prophet. To-day every one expects that all the gaps will thus be filled, and Mendeléeff's periodic law stands as a great monument to the unassailability of the higher law of continuity, of which it is but a special case. We may never find the fourth and the other dimensions; so, too, we may never discover the elements that are to fill some of Mendeléeff's gaps; but in the one case, as in the other, we must assert that they are somewhere—geometry and common sense alike declare it.

But there is one rock on which, sooner or later, every thinker on this subject splits. It is almost impossible to avoid trying to obtain a visual mental image of a body having a fourth dimension, or of space in which higher dimensional motion should be possible. Such a mental image, by the physical conditions of our existence, appears to be impossible; at least, so far as I know, no one has ever been able legitimately to attain it, though we may imagine three-dimensional results, such as the hollow ball turned inside out, and may even construct geometrically the projection of a four-dimensional figure on three-dimensional space. This inability to form a mental image has led many to give up all thought of the matter, whereas, a little reflection will convince any one that it has absolutely no bearing on the case. Our mental images are made up from our physical experience; we cannot therefore hope to image

any condition of things that is opposed to all that experience; nevertheless we may be logically compelled to admit the possibility of such a condition.

In fact, we must not depend on our imaginations; they may lead us astray, just as they have led thousands of others. The chemist did not imagine the properties of his undiscovered elements; he reasoned them out, and the geometer must not ask his imagination to aid him with the undiscovered dimensions—enough for both that their properties may be deduced by unerring logic; for the rest, we have only to believe, and to wait.

MEDICAL EDUCATION IN AMERICA.

By John Madden, M.D.

The President, in his last annual message to Congress, recommended the establishment of a National Public Health Department in the following language:

"I am entirely convinced that we ought not to be longer without a National Board of Health or National Health Officer charged with no other duties than such as pertain to the protection of the country from pestilence and disease. This would involve the establishment, by such board or officer, of proper quarantine precautions, or the necessary aid and counsel to local authorities on the subject, prompt advice and assistance to local boards of health or health officers in the suppression of contagious diseases, and, in cases where there are no such local boards or officer, the immediate direction by the National Board or Officer of measures of suppression, constant and authentic information concerning the health of foreign countries and all parts of our own country as relating to contagious diseases, and consideration of regulations to be enforced in foreign ports to prevent the introduction of contagious diseases into our cities, and measures which shall be adopted to secure their enforcement."

Equally with the right of enacting sanitary laws is the right of the General Government to provide for the education of physicians, to say what shall be the minimum of attainments before the degree of Doctor of Medicine shall be conferred upon any one who wishes to practice medicine and surgery. With this matter, however, the General Government has done nothing, and the State but little. Almost any association of individuals can obtain a charter from an accommodating legislature authorizing the establishment of a "medical college," and the process of manufacturing practitioners of medicine begins forthwith. There is no system of censorship, no commission of education, to say what shall be the test by which the fitness of the teachers of this new institution shall be judged, what the nature and extent of its laboratory facilities, of its hospitals for the bedside demonstration of disease phenomena, nor what shall be the preliminary education of its students. In fact, it may be and often is a mere business enterprise gotten up for the purpose of advertising a few ambitious men of rather doubtful ability; while the education of medical men is a secondary consideration. No matter how illy prepared the candidate may have been upon his entrance into "college," and no matter how short or superficial the course of instruction may have been, a diploma from an institution of this kind entitles him to the protection of the law, and qualifies him to give expert testimony upon any subject in any way related to medicine or surgery. In some States there are Boards of Medical Examiners whose authority is necessary to legalize a diploma; but even in these States the road to a doctor's degree is altogether too easy to travel.

The objection to schools of this kind, then, is that the training they give is insufficient. Their courses of instructions are too short and necessarily superficial. The preliminary education of their students is practically nothing; and no matter how earnestly they may work, they can acquire no thorough medical education. The most that can be done for them is to point out the way they should go to become competent physicians; and this competency must

necessarily be obtained in practice at the expense of their patients if it is obtained at all.

It is not the purpose of this paper to discuss the merits of such institutions as are confessedly divorced from the teaching of medicine as an experimental science. It should be remembered, however, that their charters enable them to confer the degree of Doctor of Medicine, and their graduates are entitled to all the rights and privileges guaranteed by law to the medical profession. There is no department of medicine or surgery which the exclusive "pathist" or "therapist" may not invade, assured of the law's protection in all the crimes he may commit in the name of medicine, and honored by the laity with the title of Doctor.

Earnest medical men recognize this lamentable state of affairs, and a good deal of effort is being made by individual colleges, and by some concerted action, to compel the better education of physicians. Better preliminary training for entrance, and more especially a longer course of study before graduation, have been adopted by many of the best schools; but the good which has come from this improvement is largely neutralized by the conduct of the scores of unworthy schools whose requirements for entrance and graduation are very easily complied with. "Students need have no fears of the entrance examination," may be read in the annual announcement of one of the schools of this class, and the language of others I have before me, though less direct, means the same. Students failing to pass the entrance examination of a school which is honestly trying to properly train young men and women for the work of the physician and surgeon, instead of increasing their capital stock of preliminary preparation, promptly seek the school whose ideals are not so high; and those who fail in the first or second year's work in the school of rigid discipline promptly carry their fortunes to the institutions which advertise that their requirements are easily met. It should be remarked here that the student is received in open arms by his new alma mater, and given credit for "all the courses of lectures" which he listened to in his former college, whether he learned any-

thing from them or not. The most that is required of him is a certificate from the secretary of his former college, simply stating that he was a student of that college for the time the courses were given. "I'm going to leave this —— school," said a young man to the writer once after an examination, "and I'm going to a school in ———, they will graduate a man there who could not pass a 'quiz' here." The speaker had been a student of the school he anathematized two years. He had been admitted on a country district school teacher's certificate obtained in one of the "back" counties of the Southwest. He was plainly and picturesquely unfit to begin the study of medicine, and it would have been manslaughter to grant him a license to practice. He went to the institution that made graduation easy, and probably secured what his ambition craved; for his second choice has the reputation of never "plucking" a man. A few months ago a graduate of this same school was put upon the witness stand in a court in Wisconsin to give expert testimony as to the insanity of a man charged with murder. He said something about the prisoner having had inflammation of the optic nerve. When asked to describe in full the phenomena of this condition, he said it was "a kind of weakness of the nerve," and here his information and descriptive powers failed.

Another school of this class is responsible for conferring the degree of Doctor of Medicine upon a man of whom the following statements are true. He was so totally lacking in preliminary training that he could not write the simplest English intelligently. He once asked the writer of this article to dictate, and he would write, a certificate setting forth that a certain person had been injured and was unable to appear in court. Glancing over what he had written, the first line read, "To whome it may consern." Further on in this choice bit of manuscript was the word "torge." What did this mean, this t-o-r-g-e? "Why," said this genial ignoramus, "don't you know what torge is? when you go nearer anything." He meant "toward." This man attended a medical college five months. He had a family to support and no

more money to spare for an education at that time. He then obtained employment as a street car conductor, in which occupation, according to his own admission, he was engaged continually for a little more than seven years. He then found himself possessed of sufficient funds to enable him to attend another five months in the same "college," at the end of which time he received a diploma and began to practice medicine. The man afterward attended one of the better schools for a period of four months, and a diploma of that honorable institution now hangs on his wall. This diploma, however, does not keep him from committing offenses in the name of medicine.

Dr. F. W. Reilly, of Chicago, in compiling some statistics relating to medical colleges in the United States and Canada, received the following letter from Yale University. I give the letter in full because it accurately portrays what the best medical schools are trying to accomplish. The figures show sixty students in the first year, twenty in the second and only fourteen in the third, says the letter:[1] "You will note that there has been a larger number of students in the first year than in the second or third. This has been due to the fact that a very considerable number of students fail at the end of the first year, and then they have to repeat their work. Our entrance requirements are placed at the high school grade in the subjects in which we require examinations, and these requirements are well enforced, yet we have this large percentage of failures of men who cannot stand the work of our first year. I do not know whether this is the experience elsewhere, but certainly our matriculation requirements are higher than the average of the country, and the whole thing seems to me to be a strong argument for the necessity of a higher grade of matriculation. I have felt for some time that this matriculation requirement was more needed in this country than the increase of time of study; that is, that three years with well prepared students would be better for the profession than a larger number of students kept at their work a year longer. This opinion,

[1] Journal American Medical Association, January 12, 1895.

however, does not seem to be the one which has prevailed. We have delayed starting the four years' course, hoping that there would be a general increase in matriculation requirements first, and while we do not altogether give up the hope of increasing matriculation examinations, we are about to adopt a four years' course in conformity with other schools of the better class." It is evident that those of the first year students who are obliged to repeat their work do not do so in Yale, else there would be no such constant difference in numbers in favor of the first year group.

Another letter from a well-known school, contributed to the same article, says, "small attendance in our second course is attributed to the fact that those who attended with us in 1893–4 can graduate in ..... medical college at the end of this term, while we would require them to attend to the end of 1895–6."

The author once heard the dean of a medical faculty severely censure the professor of physiology of the same faculty because thirty students out of one hundred and twenty failed to pass the examination in that study. It was admitted that this teacher had unusual ability in clearly presenting the subject he taught, and that he had made valuable contributions to the literature of physiology. It was also admitted that he asked only such questions as should be answered by the student of average attainments. The plea was that such examinations tended to drive away many students who would seek their diplomas in less worthy schools, and that the cause of medical education would thereby suffer. In other words this college wished to raise the standard of education, but its own preservation warned it to do so cautiously; the examinations were, therefore, to be such as suited the capacity of the students, regardless of their acquaintance with the subject. This school, by the way, was one of the pioneers in adopting a three years' graduated course of study, since extended to four years. That it has not shrunk from its duty to higher medical education is evident from the fact that its first-year class has one hundred and sixteen students, while its fourth-year class has sixty-five. The

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weeding-out process still continues, but it is to be observed that even this school could not live up to its ideals in face of so much unworthy competition.

To cite any number of cases illustrating the harm done by the actual sacrifice of life and health to the ignorance of improperly educated physicians is unnecessary. Every qualified intelligent man who has been in the practice of medicine for ten years could contribute a good-sized volume on the subject. It is not to be expected that any system of education will give unerring judgment and invincible skill. The sins here condemned are those which are born of that lack of knowledge which every man of ordinary intelligence would be able to acquire in a proper medical training. For obvious reasons, too, it is not possible to be specific as to those schools which are lamentably lacking in the instruction they give, but they are known to physicians, and their name is legion.

There are at the present time about eighteen thousand students in the medical colleges of the United States. Of this number about five thousand (five thousand and fifty-two) are enrolled in schools which have students in four-year classes; but only four hundred and seventy-five are doing fourth-year work. Five other schools having an attendance of five hundred and fifty-nine students have established four-year courses; but, as yet, have no students doing fourth-year work, and three schools having an aggregate attendance of one thousand and sixty-three announce that a four-year course will be established next year. We have then six thousand six hundred and seventy-four students attending schools which have established a four-year course of instruction, or have decided to do so next year, about thirty-one per cent. of the entire number. There are many excellent schools which still have courses of instruction extending over a period of only three years; but many schools graduate their students after two years or "two courses of lectures." The fact that a school has a course of study extending over a period of four years, ought, perhaps, to be taken as *prima facie* evidence that it is giving its students a good medical

education, and a glance at the list of those schools tends to confirm this evidence; but of the sixty-eight or sixty-nine per cent. which are found in schools outside of the four-year class, it is pretty safe to say that at least one-half, or thirty-four per cent. of the whole number, are not receiving adequate medical training.

How have the efforts upon the part of the best schools to elevate the standard of medical education been met by those seeking to enter the profession? The evidence is not reassuring. While there is an increase of nearly twelve and one-half per cent. in the number of students enrolled in 1894 over those of 1893, yet there is a decrease of nearly three (two and seven-tenths) per cent. in the number enrolled in the fourth-year classes. (These figures for schools in both United States and Canada.) Commenting upon Dr. Reilly's article above referred to and from which all the above statistics are taken, the editor of the *Association Journal* remarks: "The advance that has been made in the last decade is not so apparent as to be very gratifying to the friends of higher medical education generally, or to the medical profession."

The establishment of a uniform and thorough system of medical education can never be accomplished by the medical profession alone. Those schools which recognize the needs of a higher medical education, and are conscientiously training young men and women for the practice of medicine and surgery, will draw to themselves earnest and conscientious students who seek to prepare themselves for their life work as a matter of principle. So long, however, as medical schools are regarded from a commercial standpoint, as an investment which shall pay a dividend either in fees from their students or by advertising their promoters, and are untrammeled in their conduct by State or National authority, and so long as students can be found who regard a "diploma" as so much capital invested, there will be unworthy schools and unworthy physicians. Unfortunately, too, statistics show that the latter class has about one-third of the whole number of students, and that the ratio is increasing.

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The remedy for this condition can only be found in the General Government assuming control, not only of the sanitary affairs of the country, but of all matters relating to the education of physicians. The keeping out of contagious diseases, and adopting measures of controlling the same when within our borders, are certainly not more important than properly educating our physicians. How many lives are annually sacrificed through the ignorance and incompetence of illy-prepared doctors? Who will deny that the number of these victims is greater than those of any pestilence which we strive so hard to keep from our midst? Let there be established as free as possible from political control a department or bureau of public health. This bureau should have full power to formulate a course of medical instruction; to say what the educational requirements shall be for entering; what shall be the nature and extent of laboratory work, and what the facilities for hospital instruction. There should also be provision made for examining graduates by the same authority, before a license is given to the practice of medicine. This system of education should, of course, be uniform for all medical schools, and work done in one school should be recognized and given full credit in every other school. This system would be of great advantage to the student who, with a view of engaging in specialized lines of practice, might wish to take certain portions of his course with such instructors as have shown the greatest ability in the work in which he is particularly interested, or in the hospital or laboratory most favored by locality to offer the best possible field for practical research.

It is scarcely necessary to enter into minute details of the scheme above outlined. They could easily be suggested. A National Board of Health might be formed, for instance, of the Presidents of the State Boards of Health, and the President of each State Board of Health might sustain the same relation to medical education in his own State as the Superintendent of Public Instruction sustains to the public schools of the State. Going a step further, the fitness of all candidates for positions as teachers should be passed upon by the

National Board, as well as the granting of licenses to practice medicine. To facilitate the performance of its duties, this National Board of Health should be divided into committees, and to each committee be delegated the work of considering measures of a certain class, the same as is now done in legislative bodies. Local committees or boards could be formed, for instance, of the Presidents of three neighboring State Boards of Healths for the purpose of examining candidates for licenses to practice, and for the performance of such other duties as the National Board of Health might see fit to impose.

Objections to this plan would be raised upon the ground that it would create a hardship for those who wish to study or to practice only "special systems of medicine," the various "pathists," "therapists," "scientists," "curists," the one-sided, the narrow, the deluded, and the dishonest, all of whom stand equally as "doctors" in the eyes of the laity. These objections should not be considered valid if it is granted that the Government has the same power to protect the lives of its subjects against the ignorance, incompetence and dishonesty of medical practitioners as it has against the invasion of contagious disease. Medicine is no longer a speculative science. It rests upon a broad and firm foundation of experimental knowledge, of demonstrable knowledge. He who would study it must come prepared with a liberal education, with a mind trained for observation, for investigation, and with a power to formulate general truths when the evidence is placed before him. Has not the Government the right, for the protection of its subjects, to demand that this preparation shall be made, and that this demonstrable knowledge shall be acquired, before the degree of Doctor of Medicine shall be conferred? If any one who has acquired this knowledge wishes to wed himself to any theraphy, to any special method of treating disease, let him stand before the people in his own light. He shall not announce himself to the public as a Doctor of Medicine alone, but shall always be compelled to use the name of his exclusive system in connection with his legal title. Then and

only then will he cease to be getting money under false pretenses, and his short comings will not be charged to the shame of an honorable and responsible college.

THE HERRING'S MYSTERIOUS MIGRATION.

By A. H. Gouraud.

It may be said that modern science has relatively accomplished far more in its exploration of the stellar profound than it has of the ocean's depths, for wherever orbital motion is discovered, its period and velocity, together with the mass of the moving body, is also determined. Wherever direct motion exists in the firmament above, either toward or from the observer, the far-reaching eye of the spectroscope detects its rate, and thus are revealed the secrets of the abysses of space, thus become known the stars in their courses. Not so with the waters of the sea, for even of most of its familiar occupants comparatively little is known concerning their movements and migrations, their habits, their mode and duration of life, and the circumstances that affect their abundance. They appear and they disappear, but whence they come or whither they go we know not. No scientific investigations have been more painstaking or more persistent than those into the habits of the herring, and, although much has been made reasonably certain, a great gap yet remains unfilled.

Bewildering as is the variety, and wondrous as is the immensity, of marine life, there are none of its manifestations more impressive than the movement of a great shoal of herring. The name "herring" is derived from an old German word signifying "army," a term implying order and direction; but no human army ever marched with the ten thousandth part of the number that forms the largest shoals—some of which have a population greatly exceeding that of the entire human species. A number of such bodies of fish, many square miles in extent and many fathoms deep, exist in the Atlantic and contiguous seas, each of which has been

presumed, by special investigators, to be of a distinct race, its members spawning in the same general localities and keeping together in their great migrations. One, certainly, of these great shoals has become historic, and that is the immense swarm that at widely separated intervals of time, extending over a period of at least a thousand years, has frequented the southeastern coast of Sweden.

In his eastward passage through the first of the two larger straits connecting the North Sea with the Baltic, and known respectively as the Cattegat and the Skager-Rack, the voyager, at their junction, sees before him the island-studded coast of the ancient province of Bohuslän. Uplifted against the horizon stand its gray granite hills, for the most part devoid of vegetation and presenting, in the bareness of their desolation, an aspect stern and forbidding. Yet upon this bleak and barren coast there was annually reaped, during much of the middle ages, a splendid harvest, that brought wealth and prosperity in its train; that established busy marts and attracted a thriving population. Here, along this hundred miles of naked rocks, was the famous herring fishery of Bohuslän. Here, too, was the home of the Vikings, those daring sea robbers, the flower of the Gothic race, whose swift and well-manned galleys were the scourge of every coast, the plague of every sea. Upon Bohuslän's higher seaward outlooks are found their stone monuments, sometimes with Runic inscriptions, beneath which sleep in abiding peace the fierce sea rovers who carried, even to the gates of far Constantinople, the fame of their exploits and the terror of their name.

Of these sea kings, perhaps the most famous was Olaf Tryggvesson, who, becoming King of Norway, effected the conversion to Christianity of its people. Bohuslän then and for centuries afterward was a part of Norway, and its religious conversion probably facilitated its commerce with the Christian world, into which the dried and salted product of its fisheries must have largely entered. Under Olaf and his successor occurred the first of the periodical fisheries of which we have knowledge, for it was only at widely recurring

intervals that they existed—their continuance being of varying duration, ranging from ten to eighty-one years. The length of this, the first recorded fishery, covering a portion of the tenth and eleventh centuries, is unknown; but the earliest period of commercial importance is that which began in the year 1260, lasting eighty-one years, and forming the longest of the historic series. Then it was that the foundation was laid of the great wealth of the province; then began the spread of literature and art, the mental development of its people, and the erection of some of its most notable edifices. Following this period of prosperity there was, as before, a long interval, during which the great or so-called Bohuslän herring did not appear; but in the fifteenth century there was a revival of unknown duration, the cessation of which was considered to be a manifestation of Divine wrath occasioned by the sins of a godless people. But the greatest of these fisheries was that of the sixteenth century, a period extending from 1550 to 1590, during much of which the city of Marstrand, the then centre of the industry, exported annually six hundred thousand Swedish tons of dried and salted herring, an amount not greatly inferior to the present surplus product of all Europe. This enormous yield is the more impressive in conjunction with the ease and readiness of its absorption, for the population of what was then the limited area of its consumption was but a mere fraction of what it is now. It should, however, be borne in mind that before the Reformation the civilized world was Catholic, devoutly observant, as a rule, of the numerous fast days prescribed by the clergy, and, probably, as custom formed habit, eating fish on secular days as well. Hence, our urban ancestors of mediæval times were largely fish eaters, thus were the fisheries prosecuted upon a scale of great magnitude and energy, and their cessation or material abatement became a dire calamity.

It happened, therefore, that in this, the sixteenth century, Bohuslän saw her periodical fishery at its culmination, none that preceded or followed it attaining the same development; thousands of people from other parts of Scandinavia settled

within her borders, and thousands of fishing vessels, home and stranger, frequented her waters. Fleets of foreign merchantmen visited the port of Marstrand, bearing away fish and bringing the choicest products of other climes; commerce was active; money came easily and was squandered lavishly. Adventurers and criminals, both natives and aliens, were attracted in swarms; of the population, the dissolute and the vicious formed a large proportion; gambling and prostitution prevailed without check or restraint; bloody frays were of daily occurrence, nor was murder infrequent. Owing to the prevalence of timber construction, fire was so dreaded a scourge in the towns of the province that the guardians of the peace, during their nightly patrol, were accustomed to allay the anxiety of the sleeping citizens by an hourly call, substantially as thus:

> Now the clock strikes twelve, may God still keep
> The town from fire and in slumber deep.

The age was one of blind credulity; the ignorant masses, steeped in superstition, discerned in trivial happenings, as well as in those of moment, omens of good or portents of evil—sometimes attributions of Divine favor or displeasure, sometimes of the workings of Satan. Even to the more enlightened but simple and God-fearing Swedes of that day, Marstrand was a Sodom, over which brooded a fearful manifestation of the Almighty's wrath, premonitions of which were found in a terrible conflagration of warehouses and salting houses that occurred at the first signs of the decline of the fishery. To the boding onlookers the reddened waters of the sheltered archipelago appeared to be a sign, reflected from a flushed and flaming sky, of impending disaster upon sea and land, of a coming dispersion of the fish and of a blight upon the town. They were reminded that the Divine hand was once stretched in wrath over the waters of Egypt, so that the fish disappeared from streams that were turned into blood, and that thereafter "there was a great cry throughout all the land." Thus, looking out upon their own ensanguined sea, they feared that the judgment of the Almighty was upon them; that they were about to be scourged for their iniquities,

and that the timid herring, the prop of their industry and source of their well-doing, alarmed by so baleful a manifestation, would soon forsake them. Nor were their apprehensions idle, for with a steady diminution in the catch of the fish there was also anxiously observed a constantly increasing movement to the northward, such as had attended the decline and extinction of the previous fishery. As the evidences of the approaching calamity became more marked, the people, by public proclamation, were urged to lead godly lives, to hasten to the churches and prostrate themselves in repentance; reforms were attempted, and earnest and heartfelt prayers went up from cathedral and cottage; but in vain, for darker grew the shadow, deeper the chill, and when, eighteen months later, the season opened, men looked into each other's saddened faces and realized that the fish were gone.

Whether by reason of its more energetic prosecution or from other causes, the fishery of this period was comparatively short, lasting but forty years, and again Bohuslän saw that the springs of her prosperity were dried up; again was she plunged into poverty and hardship, deepening into the direst misery and suffering, that with slowly abating rigor abided with her seventy years. The fishery of the seventeenth century, however, continued but a few seasons, and then again the mysterious army of herring, like the host of Sennacherib, melted away before the breath of the destroyer, nor was it until the middle of the following century that the ranks of the recruited swarm were once more massed in the watery defiles of the Bohuslän archipelago. This, the last great fishery in the provincial annals, began in 1747 and ended in 1808; it developed, however, but slowly, owing to the lack of skilled fisherman, for it was to a generation with whose departed grandsires its handicraft had perished that the herring harvest was revived. The education of curers and of dressers, the erection of salting houses and warehouses, were but a part of the organization of a great industry, an undertaking that was necessarily laborious and difficult but that was ultimately accomplished. The population of Marstrand was quadrupled, money circulated in abundance, villas

and princely mansions were erected, and yet again the unclouded sun of prosperity warmed Bohuslän into active life that all too soon degenerated, as before, into riotousness, profligacy and crime. To the vices of the previous era general drunkenness was added, for in the sixteenth century spirituous liquors had not become the curse of the laboring population, upon whom it descended at a much later epoch. Great as was the well-doing of the province during this period, the annual product of the fisheries fell below that of two centuries before, the abatement being most marked in the export trade. When the fishery ceased in 1808, after a duration of sixty-two years, and the gathered swarms were suddenly and hopelessly bereft of employment, the resulting suffering, misery and destitution were of appalling magnitude, and their memory and effects yet linger in portions of the province, which has hardly regained, as a whole, its former prosperity. In 1832 a chronicler of the time wrote in substance thus: "He who knew the coast of Bohuslän twenty five years ago, and now revisits it, will with difficulty restrain his tears. Then it presented an imposing appearance; from the sea arose massive structures, salting houses and fish oil refineries, further inland were revealed ample warehouses and busy cooper shops, and then beyond were palatial residences and a multitude of fishermen's cottages. Its revenues were princely; its shores were dotted with industrious throngs, and its sea studded with innumerable sail. Every night resembled a grand illumination, for thousands of lights shining from windows and aboard vessels were reflected in the still waters of the islanded sea, across which were borne the sounds of music, revelry and song, while in the day, life and bustle, cheerfulness and activity were everywhere, but now all is sadness, desolation and ruin."

The old province, rich in the suggestions of a memorable past, in the possession of a healthful climate and impressive scenery, at length won the favor of the court and therefore that of society. Soon recognized as the Madeira of Sweden, its capital, Marstrand, became the leading summer resort of the Scandinavian peninsula, for its air was balmier, and its waters

purer and brinier, than those of the Norwegian fiords or of the Baltic. The perennial prosperity of old was, however, but poorly compensated by the brief presence of even a host of summer loungers, and so from Marstrand's castled heights anxiously searching eyes wandered constantly for the signs of its return. An interval of about seventy years had usually separated the various appearances of the fish, and thus, about twenty years ago, during the closing years of the term, public anticipation was bright and hopeful.

Herring, in their migrations, are beset by a host of enemies, such as sharks, dog-fish, cod, seals and porpoises, and by innumerable birds of prey; their most conspicuous foe, however, being carnivorous whales.[1] These immense creatures hover only upon the outskirts of the shoal, without attempting its penetration, thus serving to mark from afar not only the presence but also the extent of the body of fish. By the herring fishermen they are regarded as beneficent creatures who drive their prey landward, a direction, they imagine, that without such impulsion would not be taken, and therefore at such times they do not molest or intimidate them. Looking seaward from Bohuslän's lofty crags there is observed an archipelago, studded with thousands of rocky islets, few having aught but the scantiest vegetation, fewer still being of sufficient size or fertility to warrant a habitation. Beyond glistens the boundless blue of the ocean, whose bright expanse, one November day in 1877, was dotted far and wide with numbers of spouting whales that advanced slowly and imperceptibly in an imposing line along a wide stretch of coast, thus giving assurance that the body of fish, upon whose skirts they hung, was of material extent. That the

[1] The herring whale (Balænoptera musculus) called rorqual upon the British coast has, in adult specimens, a length of sixty-five to seventy feet. In the extreme north of Norway, where most plentiful, it is hunted in steamers equipped with bomb lances, and manned and fitted out in the southern part of the peninsula. The oil and whalebone obtained is limited in quantity and deficient in quality, but the carcass is towed to factories upon the shore and converted into fertilizers, which additional return insures a remunerative but exhaustive fishery. The herring fishermen attribute the scarcity of fish to the lack of whales to drive them landward, overlooking the fact that sharks have greatly increased and that the herring are harried, no less than formerly, by finny enemies.

shoal was of unwonted character was evident from the presence of strange sea-fowl that hovered over it like a cloud, chief among which was the rinkya or kittiwake, an Arctic gull of remarkably graceful flight and infrequent upon those shores. With these strangers various familiar species feasted upon the finny swarm, but the old time gannet or solan goose, that was attendant upon former great migrations, and which is so destructive to the herring shoals upon the Scotch coast, was upon this occasion absent. The next day all doubt was dissipated, for it revealed the presence of the old or great Bohuslän herring, that, after an absence of sixty-nine years, had returned to the sheltered waters of the archipelago. It should be borne in mind that the presence of smaller, less abundant and less valuable varieties of herring is almost constant upon the coast; it is, however, only the garnsill or genuine sea-herring so-called that is periodical and that affords the basis of a great fishery. It is what is called an inmeat herring, is large and fat and of a length varying between eleven and fifteen inches.

From the time of its last appearance to the present day the fish, at its accustomed season, early winter, has returned to the coast, at first in limited number, but since gradually increasing. The construction of railroads and the facilities of coastal steam communication have diversified the industries of the province, and even if the fishery should attain its former magnitude, it is not likely to become, as of old, the dominant industry. The drunkenness that prevailed during former great fishery periods has given place to comparative sobriety and order, a good result that is largely the outcome of the workings of the celebrated Gothenberg license system, so named after the largest city of the province, and in which the measure was devised, enacted and put into effective operation. Its provisions, now extended to every leading city and town in the Swedish Kingdom, have greatly diminished intemperance, although permitting the sale of the cheapest grade of liquor, as low as a cent for a small drink. Founded in the seventeenth century by Gustavus Adolphus, the development of Gothenberg was languid

until the Napoleonic wars, which stimulated it to a wonderful degree. Possessing the finest harbor upon the coast, and an energetic population that in wealth and number have made it the second city in Sweden, it has substantially absorbed the fishing and other trades of Marstrand, which is distant but little over twenty miles.

As yet the herring are far less abundant than during the last period, the diminution of the shoal being perhaps due to its having been, during its long absence, more actively depredated upon. That interval has seen the substantial creation of a vast British fishery, of fleets of well-equipped vessels, that with little regard of wind or weather follow the shoals far from land, and possessing improved devices of wholesale capture, much more effective than those of a century ago. The Bohuslän swarm, in its mysterious and unknown wanderings, whether upon the British or Norwegian coast or elsewhere, has doubtless been harried and beset as it never was before, and thus may return in diminished strength to its former haunts. There are many who maintain that the herring, immense as they are in number, are nevertheless diminishing. Forty years ago the British fisherman was accustomed to carry his nets upon his shoulder, now he needs a cart, and despite his larger equipment and increased appliances of transport, his individual catch is less than that of a generation ago. Then the herring in enormous bodies approached close to the land; now they are sought seaward, and the great shoals are soon broken up into schools.

The alternating development and extinction of the Bohuslän fishery, with its varying periods of prosperity and distress has naturally occasioned much speculation and discussion among the learned and the unlearned, and the resulting literature is abundant, but the conclusions reached are far from being harmonious. The regular absences of the fish from the coast for periods of about seventy years suggest the operation of some occult influence, some mysterious law, unvarying in its interval of manifestation, and which one learned essayist connected with the recurrence of sun spot periods. Speculative writers have inferred a relation of such to periodical

pestilences and famines, but an application of the theory to the erratic movements of marine fish appears less plausible. None of the theories advanced is satisfactory, the riddle being apparently beyond solution. To the objection that it is a mere coincidence, it may be said that the three last periods of absence were of sixty-nine, sixty-six and sixty-nine years respectively, and that prior to 1550 no records of the fishery were kept. We know, however, that each of the unrecorded periods formed the greater part of a century, and are therefore warranted in assuming that they approximated those already known. The duration of the fishery has varied from ten to eighty-one years, but the intervals seem to have been fairly uniform.

At the outset of their annual migration the herring rise from the deep, and upon attaining the surface direct their course landward in an immense body of such a breadth and depth as to alter the very appearance of the ocean. As they proceed they divide into distinct columns, each five or six miles in length, the waters in their front being impelled in a gently rippling wave; sometimes, as though by a common impulse, the column sinks from sight, and after an interval again emerges from the depths. In bright weather it moves steadily onward, reflecting a variety of colors, like a field of precious gems; above hover gannets, gulls, and other feathered destroyers; below various predatory fish dash ruthlessly at the moving mass; while upon its margin, along flank and rear, and working the greatest havoc, are ranged the whales. It is by this portion of the hapless swarm that the brunt of the attack is often sustained, and it is in the rearmost ranks that the swath of slaughter is widest. Overhead, upon tireless and swiftly beating pinions, circle, in a bewildering maze, clouds of wildly screaming sea-fowl, whose downward swoops are sometimes supported by hosts of porpoises, sharks, cod or other fish that have followed up the scent of the fragments left in the rear of the shoal. It has occasionally happened that an apparently combined charge from below has crowded masses of herring to the surface, which, uplifted by the frantic rush of following throngs, have formed an extended

mound of struggling fish, having a material elevation above the surface. Still, with ceaseless destruction below, above and about, the vast army moves forward, as though controlled and directed by unseen captains; and such there may be, veiled by the dark waters, but active in movement, and affording by example courage and confidence to their followers. In such case their march could be likened to that of some species of warlike ants that form moving armies, of which the larger individuals seem to act the part of guides or captains, stationing themselves at intervals from each other, like subaltern officers in a marching regiment, and exercising an apparent oversight or direction. This comparison may be warranted by the fact that when the shoals are broken up into schools, the latter are still led by the largest fish, to whom the leadership seems to be conceded, upon all occasions, by the smaller, irrespective of the size or number of the detachment.

There has long been a superstition among the fisherfolk that the great shoals are led by an old herring of exceptional size, strength, and activity, whose death or capture entails dire misfortune upon the fishermen. This imaginary individual has been styled the "King of the Herrings," its existence being probably inferred from the frequent progression of the shoal in a wedged-shaped mass, like a flock of wild geese led by a gander; this, too, was often the attacking formation of the old Viking hosts. With the Scotch this presumptive leader has been generally identified with the European species of shad, which, like our own, is of the herring family, the similarity of the larger to the smaller fish being about as close as that of a rat to a mouse. The Scandinavian king, is, however, a very different fish, and his enthronement and revelation were simultaneous. In 1776 a new species of bandfish, of enormous size, was captured off Bergen, in Norway, and as the great herring shoal was passing at the time, it was forthwith declared king. As the species are purely deep sea fishes it is not unlikely that the specimen followed the herring, or became intermingled with the shoal in its upward rise from the deep. At long

intervals it has since appeared, only about thirty in all having been captured upon the British and Scandinavian coasts together, most of which are preserved in museums. Its appearance is extraordinary ; it is narrow and flat like a silvery ribbon, sometimes attaining a length of eighteen feet, the head being ornamented with a tuft of fragile spines like a peacock's feathery crest, so that of the two claimants of the regal title, the Scandinavian alone bears the emblem of royalty, the Scotch, like the famous pretender of 1745, being the uncrowned king.

It is, of course, the instinct of self-reproduction that impels the migration of the herring, and the sense of mutual aid and protection conferred by a compact organization doubtless masses them into an orderly, moving horde, of which the subsequent division into columns and afterward into schools, may, perhaps, indicate that the latter, in some degree, is the associative unit. In their retirement it is not unlikely that they are diffused over a large area, within some part of which is probably a common point of assemblage. It is an interesting speculation as to whether the various communities converge separately, or whether the scattered detachments are first gathered into formations of millions, the millions marshaled into bodies of hundreds of millions, corresponding to the columns, to then unite to form the vast central shoal of thousands of millions. However accomplished, it must be then, with doubtless a common perception of the completeness of their organization, that the enormous host, pervaded with the anxieties of a dawning parentage, quit the obscurity of the deep, to rise at the mouth of an open tomb.

XUM

"APERGY:"[1] POWER WITHOUT COST.

By Charles Morris.

Considerable attention has been given in previous numbers of the New Science Review to the researches, discoveries, and theoretical conclusions of John Ernst Worrell Keely, the inventor of the notable "Keely Motor;" quite sufficient, it may be, in the opinion of many readers, in view of the technical language employed, and the fact that the utility of these inventions has not been demonstrated to the satisfaction of the general public. Yet the publishers of the Review have excellent reason to believe that the results of Mr. Keely's researches are all that have been claimed for them, and that this fact will soon be publicly demonstrated. They desire, therefore, to offer to their readers a plain, matter-of-fact, business-like statement of what Mr. Keely has actually accomplished; and the writer of the present paper has been requested to visit the workshop and investigate the apparatus of the famous inventor, and to state plainly and simply the results of his investigation.

Before making this statement, however, some preliminary remarks are necessary. For many years past the Keely Motor has weighed upon the consciences of Philadelphians as something they ought, in duty bound, to father, as a *sui generis* product of the Quaker City, but of which they grew more and more distrustful as years of promise and non-performance passed by, until they ceased to be in a waiting mood, and fell into one of cynical disbelief. It must be acknowledged that there was warrant for this. It has been at various times announced that Mr. Keely had overcome the difficulties that environed him, had perfected his machinery, and was prepared to demonstrate its workable powers. Yet this promise, on each occasion, failed to be fulfilled; the outcome being that doubt grew general, and many people came to look upon Mr. Keely as a shrewd adventurer, and his motor

[1] The reverse counterpart of gravitation; see Review of "A Journey in Other Worlds," by John Jacob Astor.

a skilfully devised fraud. It is true that this opinion is confined to people who have no personal acquaintance with Mr. Keely's achievements. It is not entertained by those who have had the opportunity to form a well-founded opinion; the capitalists who have supplied Mr. Keely with the funds for his experiments, and the scientists and mechanicians who have seen and studied the workings of his apparatus. But these are the few and the non-insistant. They are satisfied with their own knowledge, and do not trouble themselves to pose as missionaries. The public has been permitted to hold what opinion it pleased, Mr. Keely's supporters being content to wait until they could offer that most convincing of arguments, a practical demonstration of the working-power of the much-discussed Keely motor.

This is the state of the case as it now stands, with the important exception that the parties directly concerned express themselves as satisfied that the period of probation has at length passed, that the Keely motor is now a practical reality, and that the problem of producing power without cost is solved. For this statement, however, Mr. Keely is not personally responsible. He claims to have overcome all the major difficulties, but states that he has certain minor steps of application yet to make.

As regards my personal knowledge of the question under consideration, I can only state that hitherto I have belonged to the party of distrust. Knowing nothing from personal experience of the matter, and merely aware of the long-drawn-out agony of promise and non-performance, I have, like the rest of the brotherhood of ignorance, looked on the affair with incredulity, though not without a mental reservation that there might be some fire below all this smoke, and that the men of affairs who have stood behind Mr. Keely's experiments for so many years were not just the sort of persons likely to be taken in by a cunning schemer, or to accept plausible statements without supplementing them with a careful investigation.

It must be evident, from what is here said, that a certain amount of preliminary explanation is necessary before any

statement of the present status of affairs can be made. The Keely motor has its history, and a relation of that history must precede description. Mr. Keely is to-day a man of about seventy years of age, a seemingly robust, well-preserved person, who may have many years of life still before him. For nearly a quarter of a century past all his time and attention have been given to the study and development of the power he had previously discovered, and to whose application he devoted himself with that untiring energy which has marked inventors in all time, and through which so many of them have overcome discouraging obstacles and achieved success. The pathway of the present inventor has not been made as smooth as many imagine. He has encountered poverty, and been saved from having the roof sold over his head only by the aid of a faithful friend. In this respect his history accords closely with that of many famous inventors in the past.

During his earlier career Mr. Keely was engaged in various pursuits. He was employed, from time to time, as a physician, a pharmacist, and in other occupations. But since he was ten years of age he has been interested in the study of tones and resonances; of those rapid and incessant vibrations which underlie all we see in the world around us, and to which all the energies of the acting universe are primarily due. It is this study which he still continues, and the power which he has developed is claimed to come from a control of these vibrations.

Man has long used those vibrations as producers of power. In fact, there is no other source of energy—unless gravity has a different origin. His own body owes to them its powers of movement and sensation. The steam-power which he employs is but a utilization of the heat vibrations of the molecules of matter. The electric energy which he is now coming to employ is a vibration of the ether—a subtler form of substance. Light and radiant heat, which also yield energy, are other modes of vibration of ether. Magnetism, in its turn, has to do with vibratory motion. As regards the practical application of electricity, strenuous efforts are

now being made to use the electric vibrations immediately, instead of through the intermedium of chemical action or mechanical friction, drawing these energies directly from nature and employing them without the need of intermediate agencies. The energies named—light, heat, electricity, etc.—do not exhaust the vibratory activities of nature. There are vast ranges of vibration which lie between these, and others finer and subtler than any of them; and man has yet tapped but a minor portion of the vast energies of the universe, the bulk of which are not to be reached by the gross methods hitherto employed. The energies manifested in the visible activities of nature are therefore but a fraction of those which are active in the movements of material and etherial particles, but which take no part in the movements of masses. How these deep lying energies can be directly withdrawn from their secret lurking places, and made to move masses of matter, is a problem to which the attention of many is now being given, and to the elucidation of which Mr. Keely has for many years devoted himself, with a seeming success which places his researches far beyond those of his recent competitors.

In short, Mr. Keely claims to have successfully handled the problem above named, that of drawing energy directly from the elements of nature. The mysterious process by which he is enabled to avail himself of these potent energies is his secret. He has kept it sedulously to himself, making his patrons familiar only with the results; in which, indeed, they are chiefly interested. It is to these results, therefore, that our inquiry must be confined. As regards these there is a double story to tell, Mr. Keely's researches having led him to two different series of achievements. For many years he had at his command an enormous pressure, which he vainly sought to make useful in the movement of machinery. But for a number of years past his researches have led him in a different direction, and a far more promising one so far as practical results are concerned.

The earlier method, that of gaseous pressure, first calls for consideration. Mr. Keely still retains, though he no longer

uses, the apparatus in which this pressure was developed and manifested. This consists of a small but strong cylindrical receiver, a lever whose long arm is weighted with an iron ball said to weigh five hundred and fifty pounds, and a lifting arrangement near the fulcrum of this lever and connected by a tube with the gas cylinder. The only material employed in this apparatus is said to have been a few drops of water, introduced into the cylinder. These Mr. Keely claims to be able to decompose by vibratory influences, and further to decompose the resulting hydrogen into its elements, the result being a gas or gases of extraordinary expansive power. For this explanation of the result we have Mr. Keely's theory only. For the pressure developed we have a well-established fact. This is that the gas confined within the cylinder and connecting tube is capable of lifting the weighted lever, though the adjustment of the arms is such that this performance requires a pressure of over seventeen thousand pounds to the square inch. The actual pressure, indeed, seems to be much greater than this, if, as some observers state, a man weighing over two hundred pounds has added his weight to that of the iron ball without bringing down the lever. Mr. Keely states that in some of his experiments a much greater pressure than here named has been shown, amounting in one instance to the enormous force of one hundred and ten thousand pounds to the square inch.

That such an effect can be produced by the disintegration of a few drops of water seems inconceivable. Yet the gaseous pressure here employed is perhaps much less than that which is readily obtained in the case of high explosives. The immense rending power of dynamite and other recent explosives is due to the great expansion of the gas arising from their sudden conversion into vapor. Could this gas be confined, its pressure might prove to be much greater than that above named. Its energy, however, has hitherto proved beyond the restraining powers of any material, while the gas employed by Mr. Keely appears to be within his control. The mystery is that it is produced from water, and that no other investigator has ever separated water into such

highly expansive gases. The charge has been made that Mr. Keely employed some secret reservoir of condensed gas, or other hidden source of power, but of the hundreds of intelligent persons who have seen the experiment in question no one has been able to discover anything of the kind, though full opportunity for investigation has been offered. Two able mechanicians, Mr. Barnet Le Van, a well-known expert in machinery, and Mr. Linville, a skilled electrician, have taken the apparatus apart and examined it thoroughly. Such men were not likely to be easily deceived, and had any secret attachment been present it would scarcely have escaped their vigilant eyes. Yet they found everything as represented, and have given a written statement to that effect. Mr. Keely has also filled the receiver with water in the presence of investigators, emptied it before their eyes, and immediately afterward produced the results above described. In truth, one needs but to see the apparatus to be satisfied that the theory of a concealed reservoir of gas is without foundation.

What followed the discovery of this vigorous power? To demonstrate its lifting energy was one thing, to apply it for the movement of machinery proved to be quite another. For many years Mr. Keely sought to accomplish this desideratum, and for as many years failed. He devised and constructed engine after engine, different in form and principle, but each proved alike useless for the purpose in view. The hidden giant steadily refused to be put to work. Over one hundred and twenty of these machines were built, each new one designed to overcome some former difficulty; again and again it was announced that the force was in harness; and again and again disappointment followed. Yet the imprisoned gas was quite ready to manifest its power. Holders of great strength exploded, wrecking the shop and injuring the inventor. Thick walled tubes, specially designed for their resisting power, were split asunder as if they had been made of paper. Despite every effort the imprisoned power refused to be held in leash.

Mr. Keely states that one skilled machinist, a Mr. McPherson, expressly prepared a tube which he defied him to

rend by gas pressure. This tube was nearly six feet long, and three inches in internal diameter, while its walls were three inches thick, the external diameter being nine inches. Its resisting force was sixty-two thousand pounds to the square inch. Yet it was rent asunder by the expansive gas produced by the inventor, the thick iron being split open for a length of eighteen inches.

The difficulty in the practical application of this power seems to have been, as Mr. Keely states, the impossibility of confining the gas in any workable machine. It was so rarified that no joint could contain it, and the instant it was admitted to an engine it totally escaped, leaving a vacuum in its place. For years the inventor sought to construct an engine that would prevent this escape; many times he believed he had succeeded, yet disappointment steadily followed, and the public incredulity steadily increased. This indefatigable effort to overcome an unyielding obstacle continued for nearly twenty years. It was a bitter fight against fate and circumstance. The inventor, feeling that he had within his reach a giant power, strove unrestingly to set at work his powerful slave. It was in vain. He was dealing with an element that refused to be confined in any apparatus not solid and immovable. All acting machinery must have separate parts, moving upon or within each other, and the necessary joints or crevices proved fatal to his hopes. The instant the gas was admitted it slipped through these and was gone.

So stood matters with Mr. Keely until a few years ago, when, fortunately for his hopes of success, a new conception came to him by accident, as he asserts; one of those happy accidents, it would appear, which only men of the unusual capacity called genius are ready to take advantage of. Just what this conception was, Mr. Keely, with business-like caution, keeps to himself. The public, for the present at least, must be content with its visible results; but these are sufficiently noteworthy to amply repay consideration. They indicate two things: First, that Mr. Keely is no longer dealing with a power arising from gaseous pressure; and, second, that he has made this power capable of producing rotation,

levitation, and other effects of mechanical energy. What he claims, in regard to the source of his new system of power, is that he is able to draw vibratory energy directly from space by the aid of special resonating expedients, and that this energy can be made to yield powerful attractive and repulsive force and be converted into vigorous rotary motion through the use of certain apparatus. The power obtained, he asserts, is duplex, or has two opposed conditions, like the positive and negative states of electricity. Mr. Keely denominates these conditions positive and negative, though with the reservation that these terms do not imply excess and deficiency, but simply opposite conditions of energy. He is able, he declares, to disturb the equilibrium of these opposed states of vibratory activity as they exist in the elements of nature, to draw them separately into his apparatus, and to produce mechanical motion as a result of the effort of nature to restore the disturbed equilibrium.

This sounds like the language employed in electrical theory; and, indeed, aside from the fact that no evident source of electricity is present, there are close analogies between the action of electro-magnetism and that of the energy active in the Keely apparatus. Yet there i a complete absence of the usual mechanical or chemical agencies for the evolution of electrical energy. The only operative appliances to be seen are certain resonating arrangements, and the mystery remains deep how these can yield force. These consist of an arrangement of slender rods or tongues of metal, which successively decrease in length, and which evidently are set to sound different notes of the scale, and of a spirally-curved bugle-shaped appliance. In addition to these a tuning-fork is employed by Mr. Keely when ready to set his machinery in motion. Thus, so far as is visible, the inventor's apparatus are in accordance with his theory of utilizing the vibratory energies of nature.

The question next in order is, what has Mr. Keely to show in support of his claim that he is able to control a supply of costless energy and employ it in the movement of machinery? The proofs of this which were shown to me are two in num-

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ber; others were described, but I can only speak personally of what I saw. The first of these indicates but a minute employment of force, yet it is significant of strange influences. It consists in the motion of a magnetic needle, pivoted in a small paper box, and placed on a cylindrical stand which was filled with small tubes. At a distance stood a globular apparatus hereafter to be described, and the globe and the upright stand were connected by a length of slender platinum wire. Mr. Keely stood beside the globe, striking his tuning-fork and applying it to the tongues of metal surrounding the base of the globe. After a few minutes the magnetic needle suddenly quivered, moved backward and forward as if in response to the notes employed, and in the end began to rotate. This movement continued for a considerable time, the needle spinning rapidly around on its centre, and only ceasing when Mr. Keely removed the box from the stand.

This may seem a trifling experiment; it is, on the contrary, a significant and unusual one. The movements of the needle, in response to the notes sounded, indicated that the power came from the globe, by the channel of the platinum wire, and not from any apparatus concealed in the stand. It is not the function of a magnet to rotate. No method is known by which such rotation can be produced in the absence of mechanical connection. No such connection existed in this instance. The only influence which could proceed from the stand, through the paper-box, to the needle, must have been one of attraction or repulsion; and science at present knows no method of making a needle rotate under such circumstances as are here described. Nor does it appear that ordinary magnetic attraction is at work, for the same rotation was produced when a splinter of wood—the stem of a match—replaced the needle, with no trace of metal except a coating of bronze-colored substance at the ends. This was made to rotate so rapidly as to become invisible, and continued without cessation until the needle-box was removed, when rotation could not be restored without a renewal of the original process. Mr. Keely states that on one occasion the rotation continued for forty days.

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The other experiment shown me was one much more likely to attract the attention of practical men, as indicating a much greater supply of energy. It is not easy to explain without a diagram, and I may not succeed in making it clear. It employs, as its apparent source of power, the globe of which I have spoken, which is externally of brass, and of some eight or ten inches diameter. This is placed on a simple stand and surrounded at bottom with the arrangement of vibrating tongues mentioned, while near its apex is a small bugle-like appendix, curved in a spiral, with the mouth of the bugle opening outward.

Some ten or fifteen feet distant from this sphere stood another and more complicated apparatus. This was in two parts. One was an upright brass circle of three feet diameter, the face of the circle being several inches in width. Through this, at intervals, were inserted metallic disks or short cylinders of peculiar formation, which passed through the thickness of the brass, and protruded from its outer and inner surfaces. These—seventeen in number—were connected by wires around the inner circle of the ring.

Within this brass circle, but having no connection with it, was a wheel, or rather a hub, with a series of radiating spokes reaching within two-and-a-half inches of the inner surface of the ring, but nowhere coming in contact with it. This apparatus turns freely on a fixed axle. It is thus completely isolated, both from the surrounding ring and from any force that might be brought to bear on a movable axle. It is apparently incapable of motion except through a propelling force applied directly to the spokes or the hub. The spokes terminated near the disks, but as they were one less in number than the latter, no more than one could, at any time, stand directly under a disk.

Such is, briefly described, the arrangement: the brass circle with its disks; the rimless inner wheel which hung loose on a fixed axle; and the distant brass globe, with its resonating appliances. A length of platinum wire, of about the thickness of a knitting needle, passed from the globe to the ring, where it was connected with one of the disks. Such was

the apparatus, which stood motionless during the first hour of my visit.

Mr. Keely now approached the globe, took up the tuning fork, and manipulated, in various ways, the fork, the vibrating tongues, and the globe. After some minutes had passed in these processes the wheel suddenly started, moved slightly, and immediately afterward began to rotate. No further manipulation seemed necessary. The wheel, once started, continued to rotate steadily during many minutes that followed. With just what force it moved I am unable to state from personal observation, having made no test. The natural impression would be, from its comparatively slow motion, and the ease of rotation of a wheel turning on a loose sleeve, that the force was slight. Mr. Keely, however, declares that this is an error, that the wheel exerts the same force whether moving fast or slow, and that when making but one revolution in five minutes it has broken ropes whose power of resistance was two-and-a-half tons, and has continued to revolve deliberately as though it had encountered no opposition. Concerning this test, all I can say is that I did not see it, though the inventor declares that it has frequently been shown to others. The mode of stopping the machine was as curious as its starting. Mr. Keely simply pulled a piece of wire of a few inches in length from an aperture in one of the disks, and the wheel instantly ceased turning, though no hand had touched it.

How is this phenomenon to be explained? Pressure was out of the question, since the revolving wheel was absolutely isolated, except from the axle. But no power applied to the axle could have affected it, since the latter was firmly fixed, and the wheel hung free, turning on a loose sleeve that was slipped freely on the axle. The explanation, therefore, of hidden springs, skilfully devised systems of wires under the floor, moved by the inventor's foot, concealed machinery, etc., fails to meet the requirements of this problem, since the movement was an isolated one, and no such mechanical force could have been brought to bear on the loosely hung wheel. That electricity was not the power employed was shown by a

sensitive galvanometer, connected with the wheel, and remaining unaffected by its motion.

Mr. Keely explains the phenomenon as follows. He claims that the motion is due to attraction and propulsion (or repulsion) exerted by the disks on the spokes of the rotating ring. He says that these disks are "sensitized," or rendered alternately attractive and repulsive by energy drawn from the ether of surrounding space by means under his control, and conveyed from the globe along the wire to the disks. Of the seventeen disks, nine, he says, are polar in their action, eight depolar. The action of the polar disks on the spokes is attractive; that of the depolar disks, propulsive (or repulsive). There being but sixteen spokes, only one can be at any time directly under a disk, and the result of the differential action of the attractive and propulsive disks, due to their difference in number, is a steady and continuous rotation. This rotation, according to Mr. Keely, can be sustained indefinitely without cost or need of further attention after the conditions are once produced; is powerful enough to do work needing great energy; and is so simple in its management that no special intelligence is required to handle it. It can be used for any kind of work, as for a street-car motor; is devoid of danger; and cannot get out of order.

I desire the reader to bear in mind that much of what is above said is given on the authority of Mr. Keely's statements. I have stated on my own authority only what I actually saw. This much may truly be said, however, that during the many years of Mr. Keely's experiments his workshop has been visited by a multitude of experienced mechanics and others, to whom the experiments above described and many others have been shown, and there is no testimony extant that any one of them has discovered evidence of fraudulent operations.

The "sensitized" disks employed by Mr. Keely in the method just described, can, as he states, be used to produce many striking instances of levitation. One of these experiments is the following: A cylindrical glass vessel, forty-two inches high, containing a number of iron weights of several

pounds each, is filled with water, and covered with an iron lid. On this is placed a small metallic disk, "sensitized," while a platinum wire connects the cover with the force-producing apparatus. The attraction exerted by the disk causes the weights to rise in the water, some of them resting midway, others apparently floating on the top, at the will of the operator. As regards this experiment, all I saw was a series of photographs showing the weights at various heights in the jar. Yet it appears to have been frequently witnessed. On two occasions, as Mr. Keely states, an observer removed the disk from the top of the jar, when the suspended weights instantly fell, crashing through the bottom of the glass cylinder. He claims to be able to make the weights move at his will, stopping at any height in the water he pleases, and passing each other as they move up and down through the water. In other words, he states that he can produce a special action in the case of each separate weight, and control its movements in the water.

The inventor claims to be able to perform surprising feats of levitation by the aid of these sensitized disks, such as lifting objects of great weight from the floor to any desired height without contact. He is also able, he says, by sounding certain combinations of notes on a sort of mouth instrument, to affect the molecular vibrations in a thick piece of plate glass in such a manner as to destroy its cohesion and shiver it to impalpable dust. A friend tells me that he saw a supported globe made to revolve by the same means, it responding in curious sympathy to the notes as they varied in pitch and combination.

Mr. Keely is at present particularly engaged on a large and complicated piece of machinery which he calls the propellor of an air-ship, and whose purpose is sufficiently indicated by its name. It is supplied with three "resonators," or broad sheets of thin metal, each set to a particular pitch, and each playing some part in the mysterious process of "drawing power from space." In addition are sundry disk-shaped and other apparatus, the whole arrangement being highly complex. The inventor does not claim that this

machine is yet in working order. He declares that, if his remaining experiments prove satisfactory, he will be able to make it float in the air, at any desired height, and with sufficient lifting power to carry a large number of people, and convey them any required distance. To the eye of the layman, however, there is nothing but the inert machine. A demonstration of its powers and possibilities must wait on the completion of the inventor's studies and experiments. The world at large, with creditable caution, will not be ready to believe it can float until they actually see it floating.

Such is, briefly stated, what I have seen and have been told of the famous Keely motor. Mr. Keely does not claim to be at the end of his researches, though he does claim the ability to do mechanical work with the rotating apparatus I have described, there only remaining the minor task of attaching a pulley to it, and thereby conveying its force to machinery. He explains his present status to be the following. During the past years he has issued stock and other obligations to numerous persons who have aided him in his researches. Before taking any steps to make his inventions public he wishes to know just how he stands in regard to these obligations. He has, therefore, issued a request that all holders of stock shall register their claims in a selected trust company, and would like, if available, to replace these varied obligations with a single series of new obligations. Not until this business difficulty is in some way overcome does he propose to do anything toward putting his inventions in practical operation.

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THE NATURE OF SOLUTIONS.

By E. P. Lewis.

Why is it that a lump of sugar stirred in water soon melts away and becomes invisible, while the spoon that stirs it remains unaffected? The sugar is heavier than water; why does it not sink to the bottom of the glass instead of remaining uniformly diffused through the liquid?

The process of solution is one of those things that we are most familiar with and yet know least about. The reason why a liquid should dissolve one substance and not another is one of the most important questions that chemists and physicists are now trying to explain. It is only recently that scientists have begun to pay much attention to such things. Belonging to the border land between chemistry and physics, physicists thought that it was the business of the chemist to study the matter, while the chemists thought that it belonged to the province of the physicist. At the present time, however, both realize that it is one of the most important and interesting problems of science, and many eminent men have devoted themselves to the exploration of this unknown realm.

No one can yet explain just what happens when a body dissolves, but we are beginning to understand how a substance acts when it is in solution. Before telling what has been learned in this direction, let us recall what we know as to the nature of gases. Air and other gases were once considered to be composed of particles or molecules which repelled each other. This was believed because if a gas is let into a closed vessel it immediately fills the entire space, as though the particles sought to escape as far as possible from each other. We now have very good reasons for thinking that the molecules of gases neither attract nor repel each other, unless they are subjected to great cold and pressure, when they are brought so close as to attract each other and

finally condense to liquids. The apparent repulsion is due to the fact that the molecules are in constant and exceedingly rapid motion, like a swarm of bees, so that in a short time they will, on the average, be uniformly distributed throughout any vessel in which they may be placed. As the molecules strike against the sides of the vessel, the repeated blows produce what we call the pressure of the gas. This idea is the basis of the kinetic theory of gases, or the theory which explains their conduct as being due entirely to their motion.

An English philosopher, named Robert Boyle, published in 1662 an important and well-known law that goes by his name, though sometimes mistakenly attributed to a Frenchman named Mariotte. He showed that if we double the pressure on a piston closing a cylinder full of any gas we will reduce its volume to one-half, and double its density or the quantity of the gas in a given volume. The volume will always vary inversely and the density directly as the pressure, so long as the temperature of the gas is not changed. This fact proves that the pressure is due only to the blows of the molecules on the sides of the vessel, and not to any attraction or repulsion between them.

Charles, a Frenchman, found that if the volume of the gas be unchanged, its pressure increases regularly as the temperature rises, and that if we could cool the gas until its pressure became nothing, the temperature would be about two hundred and seventy-three degrees centigrade below the freezing point of water. This temperature has been called the absolute zero. Heat we know to be due to the motion of molecules of matter; pressure, according to the kinetic theory, is likewise due to the impacts of the moving molecules, so that they become deprived of heat, motion, and pressure at the same time. As Professor Oliver Lodge, of England, has said, at the temperature of absolute zero the molecules of air would fall absolutely inert to the floor, and we might sweep them up in heaps. But this remark must not be taken too literally; this temperature can probably never be obtained by any means at our command, although by the rapid evaporation of liquefied air a degree of cold has

been produced perhaps not more than fifty degrees above the absolute zero.

There is a third gaseous law known as Avogadro's, which states that if we have two vessels of equal volume, each filled with a different gas at the same temperature and pressure, there are the same number of molecules in each vessel. While this law may seem difficult to prove, it has been fully verified both from a chemical and a physical standpoint.

Now we can go back to solutions. If we put a crystal of blue vitriol (copper sulphate) in a glass of water and watch it from day to day we will see it slowly dissolve. At first only the water around the crystal is colored, but gradually the color will spread upward, and after awhile the water will become uniformly blue. The solution is heavier than the water, but it has actually risen against the attraction of gravitation. This process is called diffusion, and it always goes on until the substance is uniformly distributed through the water.

What does this remind you of?

The molecules of a gas distribute themselves almost instantaneously throughout the vessel containing them. The molecules of copper sulphate do the same, but much more slowly.

If you put a solution of copper sulphate in a porous clay cup and place it in a vessel of pure water, the surface of the liquid in the porous cup will rise. The copper sulphate passes out into the water, but the water passes in more rapidly, and raises the level. This is called osmosis. Some force tends to raise the level of the solution against gravity. If the porous cup is closed by a sheet of rubber, the latter will be bulged out by this force, which has been called osmotic pressure.

If we force air into a vessel closed by a rubber membrane, the latter will bulge out in the same way.

It has been found that some substances, such as salt and sugar, will pass freely through membranes like skin and bladder, while others like gum, gelatine, starch, and albumen will scarcely pass at all. The former substances are called

crystalloids, the latter colloids. This fact is utilized in a process called dialysis by the chemists, and is very useful in settling suspected cases of poisoning. Suppose the contents of the stomach of a person believed to be poisoned to be placed in a vessel with a bottom composed of a membrane, and set in another vessel of pure water. Most of the violent poisons, such as arsenic, being crystalloids, would diffuse into the water, and thus be separated from the other contents of the stomach, composed principally of colloids. It may be that the molecules are sifted as it were, those of colloids being larger and more complex, but we cannot be certain on this point.

Osmosis plays an important part in the digestion of food by its diffusion through the walls of the stomach, and also in the diffusion of sap through growing plants. It is what causes the swelling of dried fruits, beans, etc., when placed in water.

A German named Pfeffer, about 1876, carefully studied this subject. He deposited chemically in the wall of porous cups artificial membranes which he found would permit water to pass through, but not the substance to dissolve in the water. The latter being entirely confined within the cup, he could then very easily measure the pressure due to the molecules of the copper sulphate, for instance. The osmotic pressure is evidently due altogether to these molecules, for the difference between the solution and the water outside consists simply in their presence. He found that a one per-cent. solution of cane sugar gave an osmotic pressure sufficient to balance a column of mercury twenty inches high.

He found that this pressure varies directly as the amount of the substance present in a given volume; that is, the pressure varies directly as the density. This is Boyle's law.

He found that the pressure increases regularly with the temperature, and almost at the same rate as that of a gas. This is Charles's law.

He also discovered that if he made solutions of different substances, of percentage strengths proportional to their molecular weights (which are well known to chemists), the

osmotic pressures of all these solutions were equal. In equal volumes of all such solutions there must be the same number of molecules, so we see that Avogadro's law applies to substances in solution.

Solution, then, in some unknown way, seems to release the particles of a solid from their mutual attractions, and to give them freedom to move about just like the particles of a gas, though much more slowly, owing to the resistance offered by the surrounding liquid. If this theory be true, there is no essential difference between dissolving and vaporizing a substance.

Pfeffer did not recognize the full significance of these resemblances. It was van't Hoff, a Belgian, who in 1885 pointed out that these and other experiments showed that the molecules of a substance in solution act like those of a gas in space. Since this theory was first advanced, it has been greatly strengthened by the consistent explanation it has afforded of other physical phenomena besides osmotic pressure. The theory does not explain everything that it should, and there has been great opposition manifested to it, especially by some of the English chemists, but a majority of scientists seem disposed to accept it. We have, then, a kinetic theory of solutions.

It seems at first sight as though the osmotic pressure inside a vessel would drive the water out instead of the contrary. We must remember, however, that the molecules of water are free to move in, while those of the other substance are kept inside the vessel, and it is solely to their blows against the walls of the vessel that the pressure is due. As this pressure forces the closing membrane outward, there is a tendency to a partial vacuum inside, which is counteracted by the water rushing in.

When van't Hoff first published his theory he was a professor in a veterinary school in Belgium. Many eminent German chemists attacked him severely for his presumption in advancing such views, and they made a brilliant display of wit in referring to his attempts to ride a foundered Pegasus from a veterinary hospital; nevertheless his Pegasus

carried him far above their heads, and to-day he is recognized as one of the most eminent of scientists, and the leading founder of the new science of physical chemistry, which is now one of the richest fields of inquiry.

Such analogies as those pointed out by van't Hoff, which bring under the same laws phenomena apparently widely separated, contribute more to the progress of science than the discovery of thousands of isolated facts, and without them we should soon become hopelessly muddled by the multitude of seemingly disconnected facts discovered every year.

THE PAST AND FUTURE OF CITY TRACTION.

By Lieut. F. Jarvis Patten.

The horse must go, the cable is out of date, and the trolley cannot survive it long. Such are the horizon indications of the immediate future of city and suburban traffic, a field that has seen unparalleled development and rapid changes in a single decade. It is only eight years since the first trolley line was accepted as a commercial fact by the people, who looked with serious concern at the coming revolution, not because there was any question as to its possible commercial value; but would it go? Was it a practical thing that had come to stay? That was the great question. Strange to tell, however, the Richmond, Virginia, road, the first trolley enterprise of any magnitude, went all right from the beginning, and practically demonstrated the feasibility and reliable operation of trolley systems, but it was a commercial failure within a few years of its inception. This, however, could not prevent repeated trials in other quarters of a system so evidently operative and full of money-making possibilities.

The trolley once demonstrated a practical working fact, there remained but little obstacle to its rapid and extensive growth; indeed, no change or single development in transportation has equaled it in the past. There are now over eight hundred trolley lines in operation in the United States, and

compared with this figure the entire number in Europe is insignificant. In fact, they work out all scientific problems in Europe slowly but surely, and we apply them here as soon as we find out anything about them that is half-way sure. The same truth is evident in the growth and comparative use of the electric light in the United States and European countries. Without going into detail in this matter, it is a well-known fact that there are more arc lights on two prominent streets of New York than in the entire city of Paris, yet the arc light had its birth there in the Jablochkoff candle. Brush in this country, however, was the first to make a practical and satisfactory regulation which brought this light into general use.

These illustrations, far from being off the track or "off the trolley," are entirely to the point, because storage-battery lines, trolley lines, and even underground trolley lines—by which is meant lines with the trolley wire in a conduit beneath the roadway, which has a slot as in the case of the cable to admit access to the wire—were all first used in Europe. Not only this, London has had an underground electric road, that is to say, a road that is entirely underground, in operation for years, while our first attempt in this direction in the United States is the Baltimore and Ohio tunnel connection, less than three miles in length, beneath the city of Baltimore, which has but recently gone into operation.

It is not fair, however, to make light of this enterprise because the road is short. It is, indeed, the first instance that the world has seen, as will be explained later, of electric locomotives drawing heavy express trains at a high rate of speed; doing, in fact, the duty of the highest type of steam locomotive made to-day.

The story of ten years progress in electric traction is, indeed, quite as interesting as any single marvel the new agent has produced, and if electricity does not come out on top in the long run, and there is now every indication that it will not, it will at least have served the purpose of driving every other system to do its very best, and of driving all the obsolete systems out of existence. A great promoter of the

principle of the survival of the fittest, especially in transportation, is electricity.

No sooner had the trolley gained even a foothold in the United States than a system with an underground trolley, with all electric wires underground, was installed in successful operation at Budapesth in Austro-Hungary. This system, after some six years' test, is still running, and appears to have established the operativeness of such systems.

There is, however, unquestioned advantage in any system of traction in which the vehicle is independent of any connection with other vehicles on the route, or with any central station. It is this feature, doubtless, more than any other, that has drawn millions of dollars in the United States alone, into the improvement and development of the storage battery, with no further result to-day than to establish the fact that it still requires about two tons of lead to haul one ton of passengers, and will probably continue to do so until we find some yet unknown chemical substance, much lighter than lead, that will store electricity as well and give it up when required with equal efficiency. So far this is only a dream of the chemist and enthusiast; but it is one on which mines of wealth have already been squandered. The independent vehicle, however, will always remain the ideal plan, and until we get it in some form or other the horse will not be consigned to oblivion, but will continue to do a large percentage of our traction work. If the horse, by the way, has any pride in the matter, he may well laugh at our efforts to do away with him until we have contrived a vehicle that can run away with itself. When we have done that, the horse will find his way to the meat cannery and not before.

The question of city traction on the large scale is primarily one of cost, the fare must be cheap so that the masses of people along the road may ride even considerable distances for a small consideration. Modern requirements in large cities demand a rate of speed that horses are not equal to, and it is this requirement that has brought such large capital into rapid transit systems, where the horse is already entirely displaced.

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Of all the different systems tried that operate on a large scale, the cable is accepted as the cheapest to run—up to a certain distance. That is to say, we can get more work done in proportion to the effort exerted by hauling a load by a rope, as we do in the cable system, than we can by the other well known plans; provided only that the rope is not too long, in which case it will be so heavy that it costs too much to pull the rope alone, without any car containing passengers attached to it. That is what places a limit on the operation of the cable; it costs less than steam locomotives or electricity for a short distance. If we wish to go a great distance by the cable method it becomes necessary to put in one cable after another, and a power-house for each of them.

Now the distance up to which a single cable is economical is quite small as compared to that over which a single trolley line is operative. So here we have the first advantage of the trolley over the cable. We can go many times the distance with about the same loss with a single trolley line and a single power station. The second advantage, not inconsiderable either, is that the overhead trolley wire costs much less than the cable or rope per mile, and there is no expensive conduit to build.

These items of cost have operated incessantly in the past few years to check the growth and extension of cable systems and favor the adoption of electric (trolley) systems, especially where entirely new roads were to be built.

Both these well-tried systems are of course open to the serious defect that the individual car is not a self-propelling vehicle; any accident to the cable must stop every car on the line, or with equal certainty run away with the whole lot; likewise, if the trolley wire breaks down, every car on the line must stand still until the break is remedied. It goes without saying that any system that is free from this defect will make a strong bid for public favor, with a certainty of success if the cost is not too high. With the storage battery the cost is too high, and in the present state of science this evil is without remedy. For city and

suburban work the overhead electric line, though unsightly and doubtless destined to early removal, has the field to-day by reason of low cost of construction.

The past year has seen marked changes in these overhead wire systems, especially in their application to regular railroads on which trains have heretofore been drawn by steam locomotives only; and the press has had much to say of late about the coming electric locomotive for express trains on our trunk lines. Equally amusing, if not quite as consistent with the facts, is the statement sometimes seen of late that the mule on the Erie canal is to lose his job because the boats will soon be driven by electricity taken from the new dynamos at Niagara Falls. This may come in time, but there is now more than ample use for all the fifty thousand horse-power those machines can deliver for a year or two, and the mule driver can keep his hand in for awhile.

Nevertheless, the extension of the trolley system to regular railroads, as instanced at Nantasket Beach and in the Baltimore tunnel, is interesting, and doubtless prophetic of important changes near at hand, and the air is full of speculation concerning alleged combines to monopolize the manufacture of the coming electric locomotive. Out of the two recent ventures in this direction just cited, one point of importance has been certainly established, namely, that we can now design and build an electric engine or locomotive of any desired power we please, which shall be as entirely perfect and as controllable as a steam locomotive of the same power. This was far from possible a few years ago, and is, indeed, saying a great deal when we consider how long it has taken for the steam locomotive to reach its present degree of perfection, and that even ten years ago an electric motor that would drive an ordinary street car was commonly viewed as a *fin-de-siecle* wonder.

The trains propelled by ordinary electric motors on the Nantasket Beach road are comparatively light excursion trains, but they run at a high rate of speed, and the new service has thus far been satisfactory. The system itself is nothing more nor less than a somewhat exaggerated and

rather substantially built trolley or overhead wire system, and simply demonstrates the fact that such a plan is none the less feasible on a good railroad than it is on an ordinary road across country.

The Baltimore enterprise goes farther and demonstrates much more, because in this instance the heaviest express trains are carried through the tunnel at the usual speed required of the best steam locomotives. The duty of these two electric engines will be to take one hundred trains a distance of about three miles, every twenty-four hours, the trains weighing from five hundred to twelve hundred tons, being a regular through traffic of the Baltimore and Ohio railroad.

These locomotives are provided with four electric motors, one on each driving axle, the aggregate power being sixteen hundred horses. An ordinary street car requires a machine of about thirty horse-power, which gives some idea of the relative magnitude of this undertaking from an engineering standpoint. The Baltimore locomotive weighs ninety-five tons, is fourteen feet high and nine and one-half feet wide. The drive wheels are five feet in diameter, and the maximum speed attainable with light load is fifty miles per hour, with half load thirty miles, and with full load fifteen miles per hour, which means when drawing the heavier freight trains; the express trains go at the highest speed. As these trains approach the tunnel, the electric locomotive is switched to the main track and shackled to the approaching express, which is not allowed to stop for this purpose, and the train with its steam locomotive attached is taken through the tunnel in a few minutes, and the smoke nuisance under the poor ventilation of the tunnel is thus entirely avoided.

The locomotive in this instance is also nothing more in principle than an exaggerated trolley car, made of sufficient weight and power to do the work. On the side of the track, a little above the locomotive, is the trolley line, but instead of a wire, which would hardly suffice to carry the enormous electric current required, we find a continuous angle iron rail on which the trolley wheel runs and which is supported by

iron posts that remind one more of an elevated railroad structure than a trolley road.

This is the first attempt of any such magnitude, and sets forever at rest the question of the feasibility of electric motors for lighter traffic, such as that of our elevated railroads in cities. In fact, these rapid transit systems will unquestionably all be operated by electricity in the near future; certainly all newly-constructed elevated roads will be built this way, as evidenced by the Chicago elevated system, which started with an electric plant, as well as a number of other suburban roads.

In respect to the systems of traction used, New York is singularly behind in applying the latest improvements, but this fact is the result of conditions that strangely justify the course chosen. The elevated railroad in New York, for instance, was installed and brought to partial completion long before serious thought was given to electrically operated roads. After its completion on the Ninth avenue line it was little patronized, comparatively speaking, and not until it had helped to build up the upper end of the island, and so, in a large measure had caused this locality to become the residence neighborhood of the city, did its great commercial importance and necessity appear.

When the electric car first came on the scene, the elevated system had been long completed on all the avenues on which it now runs; and talk of schemes for extension of this system of rapid transit were already rife.

Such extension when it comes, if an underground line, will certainly not be operated by steam, and if an overhead one, it will almost certainly be propelled either by an electric power system or by independent gasoline engines on the separate vehicle plan.

Doubtless, the long deferred rapid transit of the greater New York will be still sufficiently long delayed to find a second revolution in transportation well under way.

Steam became the motive power of the present elevated system by accident of time; the elevated was built too early to admit of serious consideration of any other power. There

is talk now of a change to electricity, and though the change would be highly beneficial to the public in every way, doing away as it would with the steam and smoke nuisance entirely, and the noise in some degree, the public little realize what an undertaking such a change amounts to. The cost of the change to electricity alone is the chief question, for this system could doubtless be run as cheaply by electricity as it now is by steam. Consider, however, the several hundred steam motors now in use to be discarded, and which, being scarcely available for use on any other system, would go into the scrap heap together with all the appurtenances for supplying them with coal and water. Then, again, the change would certainly have to be made without interfering with the present schedule of trains for a moment; the public would never have that, much as they rail against the methods of this monopoly.

Just as the elevated system became relegated to steam for its motive power by a mere accident of time, so by another accident of circumstance the surface roads in this city have been forced to accept the antiquated and almost obsolete cable. This circumstance stands in the form of a municipal law that prohibits the stringing of an overhead wire in the middle of a street in this town, and as long as this law is in force we can have no trolley system, and this means no electric system under existing developments, except, possibly, an underground trolley, by which is meant one in which the wire is in a conduit beneath the roadway. Many of these systems have been proposed and quite a number have been tried in this country, but their operation for one reason or another has never been entirely successful. There are, no doubt, a number of such untried systems that will work well enough, we hear of them from time to time on experimental tracks; but big corporations are averse to putting a few millions into a ditch that does not start off to pay a dividend, and can never be dug up. So it is we have the cable and other cities have the trolley.

One new departure, however, has been made in this direction. The enterprise of the Metropolitan Traction Company

has at last ventured so far as to try one underground trolley line as a test of such practice. The Lennox Avenue line on the upper part of the island has been running a few months, and has done well enough thus far; being the first of its kind, however, tried here, where the best should certainly be had. A few words concerning it will not be amiss.

Out of the many good systems offered this company, the one laid down was selected for a reason that might at least be considered good, namely: If it should fail to work satisfactorily, and it probably will in time, it can be taken up without very great loss and a cable laid in its place. Few advanced electric systems offer such an advantage, and no matter what other claim it has this one is exceptionally pre-ëminent, and the truth will not be strained to the breaking limit if it be stated that for this first trial of an underground trolley in New York the worst electric system was chosen, because it was the best cable system if failure of electrical working came to pass. The same system in every essential feature was tried in Chicago and failed. It was tried in Washington and failed. Let us hope that we will be treated to a surprise in New York.

As to the system itself, it is nothing more nor less than the old Budapesth system, which has done good enough service there where the conditions are not severe, but which has shown itself ill-adapted to the rigors of a northern winter in the States.

There is a conduit similar to that which is laid for the cable, and a slot such as we see in the cable track. This permits of a connection from the car down to the conductors in the conduit below. There we find two bare wires about a foot apart, with three hundred volts electrical difference between them, and all the power of the entire system passes presumably through the motors on the cars from one wire to the other. Now, the power will go that way, and do its work as long as there is no other easy path for it, but a singular and most persistent feature of electricity is that it never sleeps, but is always wide awake, looking for some other way to do its own business than the way intended by us

and give it but half a chance and it will find that other way to a moral certainty. Some day that conduit will get full of water, or something else will bridge those two wires, and the electric current will be there waiting its opportunity, and when the opportunity arrives it won't wait another second.

Many other systems take better care of the power than this one. There are, for instance, a half dozen excellent systems of unquestioned operativeness, which require no slot at all, nor any connection from the car to the electric wires below, which are absolutely enclosed in a water-tight trough of small dimensions less than a foot beneath the roadway.

Prominent among these is one championed by Mr. Westinghouse, which will doubtless go into operation somewhere at an early day, and of which some details were given in a recent number of the *New York Herald.* One thing is certain, the coming electric system will not be trolley, nor will it be a cross between the trolley and the cable such as we have for our first venture in New York.

What, then, is the future of traction, and in what direction do the coming changes lie? To the view that is broad enough to take in all the recent improvements in this line, and understand at the same time the revolution in power-engines that is near at hand, the answer to this question is not so difficult to see. Within a few years the gasoline and petroleum engines have been brought to such a degree of perfection in Europe that power can be had from them now at much less than one cent per horse-power per hour. This is less than a quarter the cost of electricity under the best conditions, and the horse "ain't in it," for he costs as much as the storage battery, and is just about as dirty and troublesome.

These improvements have made the horseless carriage a possibility in France. The motors on these vehicles are extremely light and very powerful for their size. They weigh far less per horse-power than any electric motor yet designed, and this engine, it is safe to say, is now down to its bottom limit of weight. The steam-engine, with its necessary boiler and furnace, weighs from five to ten times as much per unit

of power. Gas enough can be stored at six thousand pounds pressure in a small tank of light weight to run a gas-engine twelve hours; and nobody ever heard of gas being very heavy, very hard to find, or costly; coming as it does from ordinary petroleum, it can be had almost anywhere at a price less than coal for the amount of power given.

So we have here the elements of the system of a near future; effective power; certainty of action; no coal; no fire; no water; no steam; no smoke; no noise; low cost and, last but best of all, the independent vehicle—the mechanical horse—the machine that can run away with itself.

This is what is near at hand; the cable will come up and the trolley will come down—and the horseless vehicle will in another decade move silently along our streets like an animated bicycle with many passengers.

THINKING ALL OVER.

By Paul Tyner.

Your body is the temple of the Holy Ghost. I Corinthians, iii.: 16, 17.

It has been well said that man, being a creature of five senses, he who lacks one of these senses is only four-fifths of a man, and if he lacks two he is only three-fifths of a man. This is certainly true in regard to thinking. Man is a thinking animal, "As a man thinketh so is he." The coming man, the complete man to-day, thinks all over; thinks down to his feet, and very particularly in his feet and in his hands. The great trouble at the base of most of the diseases, moral, mental and physical, that prey on humanity, in the individual and in the social organism, is unbalanced thinking; too much concentration of thought in the head, or in the breast, or in the stomach, or in the emotional centres, and consequent neglect of the other centres and of the whole, retarding the development of the power of thinking all over.

The whole body it is that is the temple of the living God; not the garret alone, nor the basement, nor any of the many stories that lie between these two. All are intimately

related, marvelously interdependent; no member or function of the body can be entirely healthy while another is diseased. This is a familiar fact of every-day life, yet the average man persists in regarding the organs and members of the body as distinct and separate in the individual organism, as the anarchist seems to regard the various parts in the social organism.

"Specialization" is credited with much of the glory of recent advances, especially those in the domain of the physical sciences. We even hear it said that whatever may have been the loss to the individual whose life has been given, say, to the thorough dissection of a frog's leg, humanity has gained more than would otherwise be possible. Is this not a fallacy? Does it not seem, rather, that the highest attainment of the specialist in any branch of knowledge but marks the advance in every branch of knowledge attainable by every human being, given equal opportunity for the fullest culture of all the faculties?

The beginning of Napoleon's downfall may be said to date from the hour when he accepted and uttered the aphorism that "It is not the heart, but the pit of the stomach that moves the world." The saying unfortunately embodies that most dangerous of all lies, a half truth. Powerless as the heart and the head may be without the support of the stomach, the stomach is as certainly powerless without health of head and heart to sustain it, and all three are powerful precisely in the degree in which they are working together in harmonious coördination.

Why is the poet—the genuine poet—always far more cultured than the pedant? Can there be any doubt that a Burns, or a Shelley, or a Keats, or a Wordsworth was much richer in the truest, deepest knowlege and culture than was ever a college professor whose life was given over to the study of books? Of course, this is not to say that the poet has no need of "book learning." Our own Longfellow and Lowell, and England's lamented laureate, were certainly all the greater poets for having had the advantage of university training. The lack of it did not prevent Poe from being a

poet—with it he might have been a greater poet; possibly it would have saved him from being one of the most wretched of mortals. Lowell himself felt that the importance to an author of the college course of to-day is greatly overrated. He told Howells, when the novelist once bewailed his lack of academic training, that he was probably better off without it—that the originality which constitutes the chief charm and power of Howells' work might have been spoiled had his mind been pressed in the college mould. All through Lowell's recently published letters runs a pathetic protest against the fate which compelled him, for so many years of his life, to earn his bread as a Harvard professor. And in a properly regulated social organism such an atrocious sacrifice of the individual, and of all that the individual's full and free development means for society, would have been impossible.

We are coming to recognize the fact that without travel and observation and experience, no amount of mere reading, or even reading combined with laboratory analysis and experiment, can make an educated man. Let us go a little further and recognize in our educational system that to derive the fullest benefit from books, travel, observation and experience, we must first have the *man*—not three-fifths, nor four-fifths of a man, but a whole man; breathing, living, thinking all over, inside and out, from the crown of his head to the soles of his feet; not in unequal sections, but in one grand whole; not with discordant notes, but in one sublime harmony. To have a clear and perfect photograph it is not enough to have a plate and expose it to a sun picture. It must first be "sensitized," and a period of "exposure" must be followed by a period of "development." True education, as the etymology of the word implies, is a "drawing out." A drawing out of what? Why, of the manifestation in greater or less degree of that universal consciousness which dwells in the soul of man and makes him a true son of God and one with the Father. It is in this sense that all learning is a process of remembering—a bringing into objective recognition of some part of that *truth* which has

always existed in the subjective consciousness; which is, indeed, part and parcel of that consciousness—of the soul itself.

The man who does not think, does not live, in any large sense of living. So the man who thinks altogether in his head and not at all in his feet is not fully alive. He cheats not only his feet, but also his head and every other organ and function of the body; every fibre of nerve and muscle, every atom of bone and sinew, every drop of the life currents, all are defrauded of their right to full development are prevented from reaching their greatest capacity for use and enjoyment. He cheats the whole man, and in so much as his capacity for human service is thereby lessened, he cheats humanity. In so much as he thereby fails to glorify God, and instead mars God's temple, he cheats his Creator!

"We know all this," I hear some reader exclaim; "but what can we do; we who are living in an age when humanity is rent and tortured by diseases and disorders of ever increasing complexity; when the moral perceptions are so clouded that men are honored for successful thievery and the poor are pushed into ever increasing depths of poverty and crime, while the rich abandon themselves to insane and suicidal sensual indulgence?"

One thing that is decidedly *not* the thing to do is to suddenly and absolutely stop living in the head or the heart, or wherever it is that you have been living too much. That remedy has been tried in the past by individuals and by societies of men, and it has not proven successful. This danger of flying to extremes is the one to be avoided at all hazards, if we would not find our last state worse than our first. It is not less life but more life, life fuller and more abundant, that is wanted in the individual and in the state; but we must not "rob Peter to pay Paul." Let us live just enough less in the brain and the heart to allow us to live more in the hands and the feet—those of us who are neglecting the hands and the feet. And those of us who are living in the hands and the feet at the expense of the heart and the head, may live more in heart and head and less in hands and feet, if we would

live in all more perfectly. In this way, ere long, we shall find ourselves enjoying a fullness of life in head and heart in their true relation to the rest of the man, far beyond that which was possible in the old way.

The brain, according to a popular, although unscientific notion, is peculiarly the "thinking machine." And this popular notion probably accounts, in large degree, for the prevalence of inordinate head thinking. It may be worth while, therefore, to remind the reader of the fact that the brain is not the originator of perceptions, impressions or thoughts; but a receptive and reactive agent, or rather one of several centres (and not necessarily the most important) of a great receptive and reactive agent so completely enveloping human anatomy that nowhere on the surface of the body can so much as the point of a pin be placed without coming in contact with it. This is, of course, the nervous system, of which the brain is simply a great ganglion. All impressions of the exterior world, *all consciousness*, come first through the sense organs, and by the impact on these of etheric vibrations. Of these, *touch* is at once the most universal, the subtlest and the most accurate. Ancient oriental writers only anticipated modern science when they declared that touch was the first sense developed by man on the physical plane, and that it contains in potentiality all the other senses that have been developed by man, and that are yet to be developed.

As has elsewhere been pointed out by the present writer,[1] there is striking confirmation of the theory that the sense of touch furnishes the key to the development of a sixth sense, uniting all the modes of perception of the ordinary five physical senses with an added quality more distinctly spiritual in that it is not bounded by material conditions, by time or space, light or darkness, sound or silence, form or color, texture or odor, but acts independently of all these conditions and appearances and yet takes cognizance of them all and of the inner and under quality, essence, meaning, *spirit*, at once hidden and displayed by forms and appearances. This confirmation consists on the one hand of the relations be-

[1] In the *Arena* for June, 1894, "The Sixth Sense and its Development."

tween sound and light or color shown by Tyndall's experiments, and on the other, in the remarkable development of the sense of touch among the blind, as instanced by the girl, Helen Kellar, who, although deprived of sight, hearing and speech, has under the training of the Perkins Institute in Boston attained such an intelligence, fineness and accuracy of perception, through this development of the sense of touch, that her performances would do credit to any girl of her age supposed to be in full possession of all her senses.[1]

It was also pointed out in the article referred to that in post-mortem dissections of the blind the nerve-cells at the tips of the fingers had been found to be identical in formation with the gray matter of the brain. It is very likely that the same would be found true in the case of the artist whose creations require skill and delicacy of touch; in the pianist and the violinist, the painter and the sculptor; as also in the wood carver, the artificer in metals, the potter, the porcelain maker, the embroiderer, and the lace maker. We all have "brains in our fingers," if we would only use them.

It should be borne in mind that the exercise of the sense of touch does not depend on actual physical contact with the person or thing touched. The difference between consciousness of a blow from a bludgeon and of an inharmonious thought vibration is only one of degree. The exquisite joy caused by the presence of a beloved one is not a matter of seeing, hearing, or smelling, as much as it is of *touch*, and in finely sensitive natures this touch is felt *before* there is physical contact.

In this connection, quotation may be permitted from Dr. J. Luys, Physician to the Hospital of Salpetriére in Paris, and probably the first of living authorities on the brain and nervous system. By photo-microscopic and chemical analyses of the nervous elements, he has been able to throw much fresh light on the intricate structure of the nerve cell and on the organization of its protoplasm. In his work on the brain,

[1] Perhaps a more remarkable instance is that of Dr. James R. Cocke, of Boston, blind from infancy, who not only distinguishes colors by the touch, but performs difficult and delicate surgical operations.

he points out the close relations existing between the cerebral cortex, "the true sphere of psycho-intellectual activity," and the central ganglions. He finds, in the first place, in the anatomical arrangement of the cerebral cortex, a clear relationship to a similar disposition in the gray axis of the spinal cord. Next, he demonstrates that "in the very structure of the cerebral cortex, among the thousands of elements of which it is composed, there is an entire series of special nerve cells, intimately connected one with another, constituting perfectly defined zones, anatomically appreciable, and serving as a common reservoir for *all the diffuse sensibilities of the organism*, which, as they are successively absorbed in these tissues, produce in this region of the *sensorium commune* that series of impressions which brings with it movement and life."

After a survey of the properties of the nervous elements in their origin, their evolution throughout the organism, their normal manifestation and pathological deviation, Dr. Luys arrives at the demonstration that it is by means of their combination, and by the harmonious coördination of all their truly specific energies, that the brain *feels*, remembers and reacts; that "without the presence of these living forces, that admirable and complex apparatus, the brain, would be as absolutely without life and without movement as the earth would be without the sun."

Without going too deeply into the discussion concerning the structure of the nerve centres, which has been going on for centuries, and in which every succeeding anatomist has left much for his successor to do, let us keep in mind that *sensibility* is always the primary motor agent; that it originates all movement. The external world penetrates and becomes incarnate in us through the terminal nervous expansions spread out into a net-work, open, in a manner, to all that comes to impress it. As a fundamental and indispensable condition for the phenomena of this receptivity and reaction—for the manufacture of thought, so to speak—the nervous element must be in a condition of impressionability. At the moment the sensorial network receives the vibratory excitation, it is necessary that it shall directly participate in

the act which takes place within it. It must become active; acquiesce—become erect, so to speak. It must, by a species of vital assimilation, convert the purely physical into a physiological excitation—the luminous vibration, for instance, into a nervous one.

The sensitive plexuses of our whole organism are all either isolated or thrown into simultaneous vibration, when acted on by thought, according to their various tonalities. They thus become like vast vibratory services, of which the oscillations, registered as they arrive, are incessantly transmitted to the other parts of the system and felt in the sensorium. Luys holds that this uninterrupted appeal from the external world is so much the obligatory condition of all cerebral activity that such activity ceases at once when its means of alimentation from without are cut off; just as we see the phenomena of hæmotosis cease when the atmospheric air suddenly ceases to enter the recesses of the respiratory channels.

It is well, however, to keep in mind an important distinction between thinking and the more essentially physical processes. Close as are the relations between thinking and cerebral activity on the physical plane ordinarily, it can hardly be doubted that thought is, first and most of all, a spiritual faculty, always commanding its manifestation, although in turn influenced by that manifestation. Thought is before and behind brain and body, creates brain and body, and survives brain and body, generally speaking. If thought were not, there would be neither brain nor body.

The thinking machine may be destroyed, but the thinking principle which made the machine possible lives on eternally. Man is a spiritual being, "and the spirit is the man." It is not necessary to pass through the portals of physical death to verify this fact. Do we not all know that in states of physical unconsciousness, sleep or lethargy, thinking, perception and reaction, feeling and expression, emotion and reasoning—in a word, living—go on in a sphere, or on a plane, of existence entirely distinct from the physical, but hardly less real? None the less, function needs for its own fullest development the organ which it calls into existence. And

it is not merely the brain, nor the nervous system, which is the organ needed for the fullest development and exercise of the function of thinking; *it is the whole body.* This highest function of manifested life requires not only an organ but an *organism* of the most highly organized and complex structure, every part of which, in order to serve the purpose that called it into existence, must be kept in perfect health. To this end, all the organs, all the muscles, all the tissues, all the cells, in the human body must have nutrition and use, and neither too much nor too little of either. The body, with all its parts and processes, is but the organ of thought, and so of the human spirit; but it is through the body that the soul gradually acquires that ideal spiritual self-consciousness which, here and hereafter, enables it to recognize its true nature and to "see God."

Through the awakening of sensibility is engendered that consciousness of individual personality which distinguishes man from the lower animals. Man is the only created being who can say or think, "I know that I am." And this is the indispensable step to the knowledge that "God is," and to such deliberate conscious control and direction of thought, word and deed as will manifest the spirit's recognition of herself as a child of God made in the image of her Father.

By virtue of its sensibility the cerebral cell enters into relation with the surrounding medium; its organic phosphorescence confers upon it the property of storing up in itself and retaining the sensorial vibrations which have previously excited it. Automatism of the nervous elements is merely the aptitude which the nerve cell possesses for reacting in presence of the surrounding medium, when once it has been impressed by this. "All modes of sensibility, whatever their origin," says Luys, "are physiologically transported into the sensorium. From fibre to fibre, from sensitive element to sensitive element, *our whole organism is sensitive;* our whole sentient personality, in fact, is conducted just as it exists, into the plexuses of the *sensorium commune.*"

Curiously enough, it is those we commonly call the "thinking classes" who are most guilty of ignoring and neglecting

the laws which plainly require for the fullest and most wholesome thinking the whole man, and not the brain alone; which demand that *right* thinking should be thinking all over. About sixty per centum of the whole number of professional men who offered themselves for enlistment during the civil war were rejected on account of physical unfitness for military service. Thanks to the increased attention now paid to athletic training in our colleges (although "athletics" are far from meeting the requirements of natural and rational physical training), this proportion would probably be decreased to-day. Yet it is unfortunately true, in a very large degree, that our professional classes have so far neglected the proper training and development of their bodies that the average teacher, college professor, lawyer, physician or preacher furnishes in face and figure such a travesty on the human form divine that he is fair game for the caricaturist. A notable exception must be made in the case of the priests of the Roman and the Greek Churches; a wise rule requiring that he who would serve at the altar must be as free from physical blemish or defect as the State requires the soldier to be. In many instances, too, this college training comes later than it should. At a recent competition in New York of picked public school boys between fifteen and eighteen years of age for a cadetship at West Point, only two out of ten passed the physical examination. And if there has been some slight increase in the number of professional men available for military duty, this increase has been more than counterbalanced by the effects of improved machinery, and the consequent intenser subdivision of labor, on the classes engaged in manufacturing industries. The man who made a whole shoe or a whole watch was apt to have a fair amount of "all round" development bodily and mentally. The man whose days (and often his nights) are spent in making a seventh or a seventieth part of one of these articles is sure to be lopsided in brain and body. I watched a procession of about twenty thousand men belonging to a fraternal order a few days ago in a western city. They were fairly representative of the men employed in the various factory trades and

vocations, with a sprinkling of farmers and small tradesmen. Not more than one in a hundred carried himself properly, or was straight, symmetrical and strong. Less than ten in the hundred, it seemed to me, were free from defects which would cause their instant rejection by the recruiting sergeant.

So, as one result of unbalanced thinking and consequent unbalanced doing, if the nation, to-morrow, had to summon her sons to her defense, it would be found impossible to muster into service as "able-bodied men" more than one-fifth of those who should be available, and who would be available if as a nation we recognized the plain fact, that the life which we demand of the citizen in time of need will not be forthcoming unless the nation first gives life to that citizen. Although the population of the United States has about doubled since the close of the war for the Union, it is extremely doubtful if half the number of men fit for fighting that were then enrolled could be enrolled to-day. Changed conditions of industry, or rather the failure of men to change with the times, are responsible not only for this serious showing in the direct effects on the men employed in the various industries, but also for an indirect effect of even more far-reaching importance, through the sacrifice of the mothers of the nation in mill, factory and shop.

The popular mind has misconceived a separation that does not exist in nature between thinking and doing. The Great Source of All Thought is continually *manifesting* that thought in His works. With every form of organized life, except man, to think is to do. Man alone imagines that the thinker is necessarily an "impracticable" person; that thinking is one thing and doing quite another. As a consequence, much of our thinking is fruitless and much of our doing is thoughtless.

Religion, it seems to me, has a large and hitherto untilled field in this direction. One of the greatest discoveries of the age is the fact that physical and moral education are synonymous terms, and that an abounding physical life is not only a priceless possession in itself, but also the surest foundation and security for the fullest spiritual life. The temple that

is allowed to go to ruin and decay through disuse is as much profaned and defiled by such neglect as it would be by any wanton acts of violation and pollution.

Paracelsus tells us, "There is no death to be feared except that which results from becoming unconscious of the presence of God." This is precisely the danger and the death which is incurred by the average man who, by wrong habits of breathing, standing, sitting and walking, habitually uses only about one-half the quantity of air and one-half the number of muscles he should use—thus allowing the chest to contract, the circulation to become clogged, the blood to deteriorate in quality and quantity, the lungs, heart and stomach to be injured, the nerves to be disordered and the brain weakened. Sins of omission of this order are not less serious in their effects than the sins of commission which enjoy such a monopoly of the moralist's attention.

We are in this world to ACT—not to sleep or to dream. Morality consists in right action above all else. It is only through action that man can be reunited to God, and the words *re ligere*, from which we get our word "religion," mean a rebinding of the soul (*and the body*) with its source.

Obedience to the will of God alone will bring about the reëstablishment of the harmony which originally existed between man and the divine state. By learning to know the will of God, and being obedient to it, man may bring the will of God to more and more perfect expression in his own nature—in human nature.

To act, it is necessary to feel—and to feel it is not only necessary to *be*, but also to *recognize* being. Man's soul, like his brain, is not confined to any single place in his anatomy, to his head, or his heart, or his back-bone. It is diffused through every atom of him. Yet it is but a sleeping soul until aroused and called forth by *use*. If we would have fuller life, enduring strength and beauty, it is not enough to cultivate the physical body as flesh, to develop and enjoy it on the merely material side, sinking the mind in sensual pleasure. Let us keep it, and dress it, and live in it—in every part of it—as a veritable Garden of Eden given by

God to the soul for its dwelling-place and its delight, remembering always that its beauty and its strength and its powers are desirable only as they become the conscious expression and manifestation of that soul and its purity, strength and beauty.

An instrument for Divine power, this physical body is also the soil from which the immortal in man receives sustenance and strength. As the seed takes from the earth the elements necessary to its growth, so the spirit of man can only unfold and grow in the soil of the physical body with its marvelous combination of elementary forces. Would it not, therefore, be well for us to beware lest, in losing ourselves in dreams about the "mysteries of religion," we forget God in His temple, and, neglecting this most sacred and valuable thing, the physical body, reject the stone which must become the corner-stone of the temple?

In religion, in education, in science, in politics—in the social as in the individual life—there is need, and crying need, of fuller and more vivid realization of the fact that the brain, although an important centre of the thinking and feeling mechanism, is *not* the whole of it; that the life and vigor of the brain are even more dependent on the life and vigor of muscles and nerves, blood and lungs, than are these upon the brain. We are called upon by the dangers and errors of the times, no less than by the compulsion of progress, to prove the faith that is in us; to realize vividly that if it is true that "as a man thinketh so is he," it is even more true that as a man *doeth* so is he, and that, after all, it is our *doing* that makes further thinking and further progress possible. It is only by doing always and everywhere the best we know that such doing becomes the natural, easy and pleasant habit, and *character* is formed. Every experience, every impulse, every emotion leaves a physical record and tendency in the brain and nervous system as a whole—that is to say, in the man. The different parts or areas of the brain are thus developed, and what was potential becomes real. Each part, once made alive by use, and made to work in harmony with

all the other parts, continues to act and re-act automatically upon the slightest stimulation.

Herein is a fact which points to enormous possibilities for increased economy and effectiveness in education, a fact that demands serious consideration. If, as ascertained phenomena in physiology and psychology, the child's character and power, his tastes, his sense of beauty, his love of truth, his hatred of wrong, his habits of industry, his intelligent skill in any occupation—if all these become part of his very being, dependent for their expression on the regular action of physical forces, then surely it is of the very first importance that every child in the land should have those influences and opportunities, and that actual enjoyment of impression and expression in sight and sound, in use and exercise of all the faculties of mind and body, which will show him to be really a child of God. Only when the republic gives to the citizen this life, and receives from him fuller life in return, will it shine forth in that glory of righteousness and justice which is a nation's true splendor.

THE ACTION OF FORCE IS SPIRO-VORTEX.

By Mrs. Bloomfield Moore.

The Magia is above nature and maketh nature according to its will.
Jacob Böehme.

The desire is the *fiat* which has made something where nothing was, but only spirit. Clavis.

Böehme in his theoretical analysis of the nature of will force has made an error in saying that "a substance is produced or a flow of matter induced by will force." "Will force," writes Keely, "is a latent, spiritual element, neither gaseous nor otherwise. Its evolution is brought into action under certain spiritual conditions not now understood by science. Its protoplastic element is actually luminous, in respect to its latent flow from the cerebral domain; but all the flow that has ever been registered from the time of the birth of every volume of thought—all that ever existed, or will ever exist in the future—would not produce a substance of matter the size of a molecule." Böehme says: "This operation of the outflown word becoming a passive substance is the Mysterium Magnum—the greatest hidden secret;" contending that the original of all things lies in that our ideas produce acts; that the Infinite One or the "Word of God" produced creatures. "The Magia is above nature and maketh nature according to its will."

Keely has grasped this greatest hidden secret—the power of the will—and now offers the key of the door that leads from the realm of matter to the realm of mind to all who are ready to pursue their researches in new fields.

Keely's latest discovery—that of the spiro-vortex action of currents of force—is so overwhelming in its simplicity of demonstration that it needs but to be witnessed to convince physicists that vibratory physics will place science on a height never before attained. This discovery solves problems with regard to the peculiar movements of the heavenly bodies which astronomical experts have never been able to explain

satisfactorily. It also accounts for the explosions which, for years, impeded Keely's progress during his disintegrating experiments, breaking iron and steel tubes like pipe-stems, fracturing his ribs, and at one time paralyzing him for weeks.

Keely speaks of this discovery of spiro-vortex action as an accident; but there is no such thing as accident in discovery! While seeking to establish in his new instrument a way by which a neutral centre could be more simply and definitely fixed, he resorted to an experiment that he had never made before. His indicator was registering about one hundred revolutions per second, induced by the current at a rate of nearly two hundred thousand movements in the same time, when Keely held the conducting wire against some cotton fibre at the open end of a test tube. To his surprise, upon its removal he found that the tube was cut through and through, spirally, from the interior, breaking the glass at the top in its passage out, but leaving the tube otherwise intact.

Up to this time Keely had been working on the theory that the action of the current was circular in the polar and depolar circuits of the propeller of his air-ship, both in their separate and in their combined action. But there is as wide a difference between truth and conjecture as there is between facts and theory. The abyss between the two can only be properly measured in the effulgent light of revelation or inspiration. All truth is inspired, and the mind that is highly intensified in its search after truth—"hidden knowledge"—becomes much more powerful in its receptive qualities of analysis than a mind of ordinary penetration.

Keely is still researching on the line of obtaining pure constancy of action in the aerial navigator propeller; and those who do not doubt his ability to gain this end should unite in efforts to prevail upon the shareholders of the original Keely Motor Company, incorporated in 1872, to accept the railway traction engine that he offers to them in his Circular No. II (see advertisement in this number; also of H. O. Ward's approval of same), and thus leave him free to continue his researches in the simplifying of his new instrument; for the present propeller is too dependent on influences

not yet understood, even to be patented, and too complicated in its operation to be used by any one but Keely himself. It will stand on record, in the history of progress, as the first and the last (under Keely's system of aerial navigation) for all time, unless his life is spared until the goal of his ambition is reached in the perfecting of a simpler machine. To this end Keely purposes to devote his life, after he has taken out patents on a railway traction engine. In no other way can his discoveries, in the interetheric field, be preserved for this and for ensuing generations.

His recent discovery as to the action of currents of force greatly lessens the peculiar complications associated with aerial navigation, which were impeding his progress in the control of the instrument while in operation.

If left undisturbed by litigation Keely will soon be able to prove to the world, by a public demonstration, that perfect control of an air-ship can be obtained, no matter what its weight, under conditions that he will then make known.

Keely stood, fourteen years ago, on the wrong side of the abyss which separates conjecture from fact. "The bridge of mist" he writes, "which spanned the chasm between the two is gradually resolving itself into one of granite, which the nations of the earth may safely traverse, stretching between the two centres; the celestial and terrestrial. The visible one is the one of mist: the invisible one is the one of granite."

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VIVISECTION.

By J. Emery McLean.

The statement that cruelty is a human instinct seems to be almost justified by the facts of history and of contemporary scientific research. It is apparently characteristic of all ages and walks of life. The average boy, almost as soon as he is able to toddle, will seize a pet kitten in preference to any other object; and his first impulse is to drag it about by the tail. When he is strong enough his tiny arms will enfold and squeeze the animal till its eyes protrude from their sockets. When at length the creature's piteous mewing informs the young tormentor that he is inflicting pain, instead of desisting he increases the pressure, till the kitten, goaded to desperation, uses the weapons of defense which nature seems to have provided for such contests with the "superior" human animal.

The subsequent development of reasoning faculties frequently fails to eliminate this barbaric trait, for the tendency of men to prey upon their fellows is the cause of restrictive and punitive legislation and of the necessity for "regulating" society. The man of wealth and culture docks his horses' tails with less compunction than is felt by his wife when, by her patronage of the fashionable milliner, she assents to the yearly slaughter of thousands of feathered innocents for the adornment of feminine headgear.

In no age of the world have even experimental scientists hesitated to sacrifice life in the eagerness of their search for knowledge. The fact that human life is now exempt from immolation on the altar of material science—that the undoubted cruelty of vivisection is confined to the lower orders of existence—is regarded by the vivisector as sufficient answer to the protests of the humane. Yet these protests are fraught with a deep significance to the moralist and with unbounded hope to the race-at-large. They point to the fact that above and beyond the ordinary plane of human con-

sciousness there is a *subjective* intelligence in man which is the mainspring of his development along the lines of truth. It is the corner-stone of all progress, and the only sure basis of moral and spiritual excellence. This is the faculty which ever operates for the uplifting of humanity, and is illustrated in the formation of societies for the prevention of cruelty to animals, children, and other helpless creatures. It is this pathetic necessity that appeals to the Christ-like spirit which is the natural heritage of mankind; and the appeal is made in vain only when, in the blindness of ignorance and wrong-thinking, we smother the divinity within.

Herein lies the cause of the suffering we ourselves endure, as well as of that which we inflict upon others. Pain is a protest—one of nature's silent and beneficent admonitions to erring man. Yet, when not unheeded, it is regarded as a demoniac entity which must be exorcised by methods which have varied with the progress of the race—from the incantations of olden times to the deadly opiate of modern medicine.

The fact that familiarity with pain breeds contempt for suffering, is proved by the popularity of certain surgical operations which have superseded the "blood-letting" practice of former years and are the inevitable result of that craze. Among the refinements of cruelty which may be justly regarded as the outcome of this surgical idea, the unnatural habit of vivisection is, perhaps, the most abhorent Its apologists claim that the practice is carried on in the interests of humanity, and that it is a necessary prelude to the study of man's physical structure, to which certain organisms in the animal kingdom are said to bear some striking anatomical analogies.

On the other hand, the more humanitarian school of experimentalists, which preceded this modern revival of an ancient practice, was content with post-mortem dissection, and this was resorted to by its votaries only when the victim had displayed marked peculiarities which failed to harmonize with their ante-mortem diagnosis. While to some orthodox minds even this seemed a barbarous custom, it must be admitted that, as no actual suffering was caused, no harm could

result from the use of the anatomist's knife. It is undoubtedly true, also, that much useful knowledge has been gained from this analysis of the human body, though the frequent discovery of evidences of premature burial and the prevalence of states of coma and trance suggest the frightful danger of its having often resulted in murder.

Both schools have signally failed in their efforts to discover nature's secret of the life principle and the true cause of disease in the bodily organism. The reason for this is obvious; in nerves or arteries, bones or muscles, neither is contained. They belong to a sphere which is accessible to neither scalpel nor drug; is impalpable alike to the organs of sense and the grasp of material science, and is susceptible of neither division, analysis, nor measurement—the subjective world of spirit.

To the true psychologist these are no longer mysteries; but it is chiefly with physiology that this paper has to deal. Of the particular branch which has resulted in the practice of inoculation with vaccine virus, lymph, antitoxine, and other extracts and compounds of animal substances, a noted scientist is quoted as authority for the following definition:

"Vivisection is the cutting up of *live* animals, and includes various other operations—poisoning, burning, smothering, freezing, breaking of bones, irritating the bared nerves with electricity, dissecting out the stomach and other organs," etc.

The recognition of the rights of man has placed the stamp of criminality on *human* vivisection, which is an ancient usage, having been practiced in Egypt, Italy, and elsewhere for over twenty centuries. Celsus states that "they procured criminals out of prison, and dissecting them alive, contemplated, while they were yet breathing, what nature had before concealed." Now that the cruelty of this is universally recognized, and the practice abolished, why should not the arguments which led to this desirable condition apply with equal force to all sentient creatures? He who is not merciful to dumb animals is cruel to his fellow-man.

That vivisection admits of the most atrocious and barbarous acts, though committed in the name of "science," none will

deny. In many instances, however, after the operation, the animals are mercifully chloroformed to death; but in others the poor creatures are tortured daily for a period extending over weeks and months. According to the statements of the vivisectors themselves, anæsthetics frequently cannot be employed without destroying the value of the experiment. A New York surgeon, in an article written for *Laboratory Researches* not long ago, stated that on one occasion he forced the leg of a dog over its back, in which unnatural position he bound and sealed it in plaster of Paris, keeping it thus for one hundred and forty-five days. In view of such published statements, is it any wonder that there are already nearly seventy anti-vivisection societies in the world?

Have animals no rights? Human rights have been acknowledged, at least in the abstract, since the dawn of civilization. Surely our four-footed friends should be accorded a like recognition, for in almost any domestic animal may be seen many traits of character which are entirely human in their manifestation. Instances have been cited in which the bond of union between a dog and his master has been so strong that the death of the latter has been followed by that of the former from excessive grief. We have all seen to what perfection animals can be trained, and this fact alone is a strong argument in favor of their natural rights. How often we see in the eye of a horse, a dog, or even a lower order of creature, a look which at once betokens love, intelligence, or devotion! The neigh of a horse when his beloved master approaches, and the joyous barking of a dog when he sees a friend, betray an instinct of love often as intense as the corresponding human quality.

Huntsmen selfishly assume that animals have been placed in this world for their special pleasure. This is a weak plea for the pursuit of a brutalizing sport; yet a far less degree of cruelty is practiced in the hunting field (and even in the slaughter-house) than in some physiological laboratories and colleges.

If one instance could be cited as productive of beneficial results to science or humanity, the torturing of animals might

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in some measure be condoned. But nowhere in Europe or America is the fact recorded that either has derived the slightest benefit from the practice. One noted authority tells us that "the conclusions of vivisection are absolutely worthless." Canon Wilberforce, of England, says: "The experiments of certain physiologists are those of inhuman devils." On the other hand, a prominent advocate of vivisection states: "It is a mild, merciful, and for the most part painless interrogation of nature and her secrets of life." With such a diversity of opinion confronting us it seems difficult to reach the truth. But of one thing we are certain; no matter what may be the motive, no humane person in dorses any act of cruelty to man or beast.

When we realize that vivisection generally takes place in the presence of a number of young students, we can readily account for the conduct of some lately graduated physicians who have been placed on charity hospital staffs. Complaint against their treatment of patients consigned to their tender mercies has become so general of late years as to call forth public protest. Another notable fact in this connection is the number of young physicians who have been found guilty of homicide in its worst forms. It is more than possible that the prevailing epidemic of this crime is indirectly attributable to vivisection. This practice so accustoms the operator to the sight of blood and suffering that eventually his finer sensibilities become blunted, and he grows as callous to human misery as to that of the dumb and helpless animals exposed to torture under his ruthless scalpel.

If the exercise of cruelty could be limited by restriction the matter would not call for such grave consideration; but in most American colleges no restrictions whatever are placed upon the practice of vivisection. "Wherever is conferred power without responsibility there will invariably follow license and abuse." This is simply cause and effect. It was absolute power that was responsible for the tyrant Nero, the dread Ivan the Terrible, the Emperor Paul, Robespierre, and many others of infamous memory. The same rule holds good with certain physicians and surgeons.

The humane man who feels it his duty to study animal life of different grades, will employ means compatible with the kindly instinct which nature has implanted within his breast. The man of brutal instinct, on the other hand, will seek a channel through which he can ventilate the inherent cruelty of his nature. Certain French and German experimentalists, whose atrocities in vivisection are facts of history, furnish innumerable instances of this. Dr. Brachet, of Paris, severely taxed human ingenuity in his efforts to devise new methods of torture, for the purpose of studying results. A dog, which he had securely bound, was goaded to intense anger, "and then," says the doctor, "when the animal became furious on seeing me, I put out its eyes. I could then appear before it without its manifesting any aversion. I spoke, and immediately its anger was renewed. I then disorganized the internal ear as much as I could, and when intense inflammation made it deaf I went to its side, spoke aloud, and even caressed it, without its falling into a rage." Dr. Elliotson, in his work on "Human Physiology," says: "I cannot refrain from expressing my horror at the amount of torture which Dr. Brachet inflicted. I hardly think knowledge is worth having at such a price."

Many parallel cases might be cited, but, in the hope that time may reveal the uselessness of such pursuits, it were perhaps better to pass them by with silent pity than to repeat them here.

Let us now examine the practice of vivisection from a metaphysical standpoint and see to what it leads. It is conceded that God created all things for a beneficent purpose. From this postulate it follows that nothing has been placed in the world that is not intended to subserve an end in harmony with the attributes of Deity. Is it not, therefore, an aspersion of the wisdom of the Creator, when we wantonly torture and destroy animal life in an effort to unravel secrets which nature has concealed? Indeed it is extremely improbable that *any* attainable knowledge is ever withheld which would be beneficial to us in our present environment.

That no useful information has been gained through vivisection is an evidence of the Creator's wisdom.

The Christian nations of the world spend millions of dollars annually in their efforts to convert the people of the Orient to their way of thinking; but when a Western student of the various Eastern religions realizes the beauty and spirituality of the doctrines there inculcated, he should hang his head in shame. Many Oriental religious sects refuse to destroy life on any pretext whatever, in the fixed belief that the killing of even a harmless insect is an offense against Deity. "*He* alone can create, and only *He* should destroy." What a beautiful faith it is which so spiritualizes its followers that *all* life becomes sacred to them!

In what strange contrast is this to the teachings of the Occident, where in the nineteenth century these same helpless creatures are tortured in the interests of "science!" Consider Pasteur, and the inauguration of his mad-dog scare, which, it is widely believed, was produced simply to afford greater opportunities for the practice of vivisection. How many hearts have been made to ache through the loss of a cherished household pet, which in all probability had not the least taint of the dreaded "virus" in its system! Since the French doctor began his experiments, hydrophobia has rapidly increased, and in some quarters it is only necessary for a domestic animal to display a little uneasiness to insure its immediate death. Hydrophobia was rarely known in former years. Many persons suffering from dog-bite, paying no further heed to the occurrence, have experienced no ill effects. The propagation of this disease was simply a result of the craze for vivisection and the effort to secure subjects upon which to experiment. Pasteur and his methods have therefore much to answer for.

Consider, also, Brown-Sèquard and his wonderful "elixir," which was to furnish the aged with the qualities of youth and to grant the young freedom from decay. After torturing numerous animals, this unique scientist made a most disastrous failure in attempting to demonstrate his theory. In many instances the results were exactly the opposite of that

which was promised, while in others, where the imagination was a factor in producing apparent success, the patient soon fell back to his normal condition and nothing was gained but well-deserved ridicule for the experimenter.

Next came Koch, with his sure cure for tuberculosis, to which an enormous number of animal victims were offered up. And what has been the result? Precisely what has attended the efforts of all other vivisectionists—absolutely nothing; and in many cases the injection of the famous "lymph" is known to have hastened death.

A tremendous evil is threatened by the recent introduction, under the head of physiology, of the dissection of live animals in certain public schools, which can have none other than a degrading effect on the plastic minds of children. It fosters whatever inherited cruelty may exist in their undeveloped faculties, and brutalizes the finer instincts of the race at the very threshold of life. Take, for instance, a class of boys in such a school, and watch the majority of them during experiments in vivisection. They seem actually to gloat over the agonies of the tortured animal, while apparently oblivious to the "scientific" teachings which their instructor seeks to impart. They appear unable to realize that it is simply a lesson in physiology. Indeed, the visual sense seldom reverts to anything beyond the immediate object of its fascination. Thus the harrowing sight, becoming photographed on the retina of the mind, dominates the subsequent acts of the observer. Incited by what he has witnessed and is unable to forget, such a student is usually impressed to undertake experiments on his own account, and often a pet animal is sacrificed to satisfy the child's insatiable thirst for "knowledge."

Does vivisection lead to crime? It does most assuredly, even among those in whom the mania has been artificially developed. How much greater, then, is the danger in the case of a child who is born with an hereditary tendency to cruelty? His evil disposition is intensified inevitably.

Mere restriction of vivisection is not sufficient. After nineteen years' experience, according to Dr. Edward Berdoe

and Sir Charles Bell, F. R. C. S., the restriction act of Great Britain has proved a failure. Total abolition, followed by the extension to the lower kingdom of the principles of justice and humanity, is the only remedy for this relic of barbarism.

SOMETHING ABOUT GENIUS.

By Floyd B. Wilson.

When a crisis arises in a nation and it demands a hero to save its life, the hero appears. When the very air breathed seems to make half the world inventors, some one is certain to arise to be called the sphinx. When people grow greedy for a better literature, the supply comes, though none may know where or how the geniuses were taught. Is there a law underlying all these facts? Are mighty thought-currents set in motion by human minds, that draw to themselves through a subtle, undefined law of attraction, as the rushing mountain river takes in the smaller brooks and streams, until an irresistible mental force is gathered creating new conditions, new laws,—a miraculous uplifting of individual mental power? Has over-study of physical phenomena blinded us to the more potent power which makes physical phenomena possible?

We have studied the genius—bowed before his God-like qualities—admired, wondered and praised him. He represents a force too subtle for analysis, we say, and his appearance is not to be accounted for by a law. We face the unsolved problems with assertions declaring them incapable of solution. We seem content with ignorance.

In boyhood one reads Emerson's "Oversoul," and thinks it rhetoric. To-day a new light is being thrown upon it. Emerson was telling of man's fountain of supply—of a force on which man might lean, if he would—of a power more certain and more wonderful in being than that of the greatest dynamo in the physical world. He was trying to

tell what the story of Christ taught him. It was a new interpretation, and all authority was against it. He cared little for authority, knowing the countless instances in which authority had proven its own falsity; and yet his readers hardly comprehended the truths he uttered. They were fascinated with his diction, but failed to grasp his thought.

Over and over again have we questioned if two people could ever be made to understand each other. We do not listen to new propositions with receptive faculties. We listen with our prejudices. All existence is a battle-field, and our narrow prejudices will battle against their overthrow though their marshalled foes be the white-clad heroes of Truth. Again and again we have seen this battle fought and won by right; still the ignorance of to-day finds its supporters and defenders in the accepted scholars of to-day. Where is our boasted intellectual growth? Where our vaunted progress? We are to-day the slaves of our prejudices; our environment is our prison-house.

The true genius is a strange compound, full of boldness, and, at the same time, excessively diffident. He is bold in his work, soaring often to heights angels dare not aspire to; and yet he meets the praises of the world with the diffidence of a maiden fresh from convent life. He seems to question if he is entitled to the honor. His best work, apparently, comes forth through him only as the instrument. Whence the creative power that flashed through his consciousness, he hardly knows. His it is, and yet not his. We may ask if it were inspiration, but what is inspiration? Who inspired him? How? Why? Can the secret be revealed? Does the higher power control him, or he the power?

First, it is to be observed that a true genius is unhampered by any conventionalities. They are meaningless to him. He is beyond the deductions drawn from the lessons of the past, and he rejects their teachings. He breaks over every environment. He has discovered a hidden force. He stands on a higher plane. Now, he never doubts, he never fears. He does not need to guess, to hope—he knows. Who gave him

this knowledge? Not books, nor teachers, nor experience. We can write denials without limit; they only deny. Must we forever deny and stop there? Denials help—they cleanse the mind of error, and then there is room for truth. If we can learn the secret of the genius we will gain in power though none of his be ours.

The genius's first step forward is not made with any rash force. He often sits listless. He waits. Waits, seemingly, for the message to come to excite him to activity. Waits for direction from a mightier force than intellect. The real centre—the dynamo of thought—is only reached when man is brought to realize that he is one with infinite power—that that infinite power without or separate from his own spiritual consciousness would be finite. Once man advances to this plane, he becomes the instrument to do the will of the All-powerful. He has then no need of instruction that books or experience may bring. His strength is supreme—doubts cannot come—he believes, he knows. Believes not church dogmas, not creeds written by man, but the truth spoken by the Nazarene when he said "The Father and I are one." The Christ within us is never assertive, and it will not manifest itself until we have learned to still the action of our hap-hazard, guessing intellect. The true spiritual self within is one with the Christ. Even Christ Himself said to His disciples, "Greater things than these shall ye do." He foresaw the possibilities to be reached by gradual spiritual development, when man should realize himself not a reflection of God, but rather the expression of God. God is all—filling all space—we are included in that all. God, being an Invisible Presence can have no personality, but man is the projector of that great Invisible into visibility. Just in proportion as one grasps this great truth, thereby recognizing and claiming his birthright, will that one manifest to the world the divinity within him.

If this philosophy be true, it may be asked why the genius may not teach it. The question is complicated—the philosophy is subtle, and is both old and new; yet, though obeying its laws, the genius, as a rule, does not understand

it. A flash of light came to him from the great soul dynamo, and then he learned of the power within. Why and how it came he did not question. He awoke to knowledge, and rejoiced in its possession. Paul's conversion was instantaneous, and Newton's discovery developed from a simple incident. For one rapt moment each, in seeming listless mood, when intellect was resting from her weary battles, found himself in complete harmony with his own spiritual self, and the kingdom of Heaven was found. The God within, always ready to help, was unhindered, for an instant, and then the work was done.

Burns, untutored, caught a glimpse of that divine light, and sang the songs that gushed forth from his soul. He merely uttered what his inner consciousness breathed. He could not help it. He was only the instrument to record the melodies God (his subjected self) sang while he listened.

Lincoln, withdrawing his gaze from the smoke and horror of the battle-field, saw freedom fettered and humanity outraged, and the God within him spoke—the emancipation proclamation was published—and a whole nation, startled, saw that its President in reaching one hand down to the slave had grasped the God of the Universe with the other. By that act a new force was created which saved the Union. A thought current was established, bearing on its bosom the emblem of right and freedom, and naught could resist its progress. The intellect never gave birth to such a God-like deed as that.

We may never know how Bulwer came to write "The Coming Race." He may have studied Eastern thought, and naturally reflected some of its teachings. If not, then it was his inner consciousness—his soul—that taught him the possibilities of *vril.*

Chatterton's active (or every-day work) mind was completely obliterated or unhinged by the spiritual self within. The prose of life was torture to him, for the material is not of the spirit. He became over-spiritualized for his physical strength, and having tasted the joys of Heaven he could not endure the cares of this work-a-day world. The intelligence

surrounding him failed to understand him, so he rashly destroyed both his works and himself.

What light burst upon Franklin that led to his flying a kite in the midst of a thunder-storm? Why did Morse conceive the telegraphic alphabet before he made a test? What power directed Shakespeare when he wrote, "I'll put a girdle round about the earth in forty minutes?" Whence comes the mighty power of a single word like patriotism? Is not love as real as existence, and what has its genuine force to do with intellect?

If one may gather from all this that the genius touched some hidden spring to wake his inner consciousness (soul) to action, and to take control of his work, the inquirer now comes abreast of the subject before us with the momentous question, HOW? Does he stumble on the concealed button? Though a law may underlie the result of the pressure, is there a law which will tell one how to find the hidden spring? If it be conceded that our argument thus far is correct, that it is the soul's awakening that creates the genius, that that done a law is carried out which is irresistible; then it is equally certain that this acquaintance with the true ego can be obtained by a law as clearly defined as the one by which the ego acts. Is any other conclusion possible? To concede the one, we must concede the other. What is there in the experiences of geniuses that is tangible on this subject? Have any of them written anything to suggest that they had found the centre of being in themselves? Let us see. Matthew Arnold was certainly directed by none of the dogmas of religion when he wrote:

"Once read thy own breast right,
And thou hast done with fears;
Man gets no other light,
Search he a thousand years.
Sink in thyself! there ask
What ails thee—at that shrine."

He wrote this from the centre of being. He knew the world was not yet ready for it, because he was a teacher and knew the generally accepted philosophy.

Robert Browning was bolder. He lived more at the centre. He wondered why the general reading public could not understand him. He repeatedly declared himself openly; but few of the world of readers grasped the great principle —that imagination and the soul, the center of being, are one. How could Browning have expressed himself more clearly on this subject than in these lines:

> "Truth is within us all; it takes no use
> From outward things, whate'er we may believe
> There is an inmost centre in us all
> Where truth abides in fullness; but around,
> Wall upon wall, the gross flesh hems us in."

In the Epilogue to Beaumont and Fletcher's "Honest Man's Fortune" we have convincing proof that these writers, in reflective mood, clearly recognized the power of the soul:

> "Man is his own star; and the soul that can
> Render an honest and a perfect man,
> Commands all light, all influence, all fate;
> Nothing to him falls early or too late.
> Our acts our angels are, or good or ill,
> Our fatal shadows that walk by us still."

Shakespeare, the unapproachable, turns on the search-light, revealing the mystery over and over again, but only holds it to the centre for brief instances of time, then dashes into the materiality of life:

Hamlet's

> "There are more things in heaven and earth
> Than are dreamt of in your philosophy"

is suggestive of knowledge Shakespeare himself possessed but might not speak; while,

> "There is nothing either good or bad, but thinking makes it so,"

is a positive statement of truth a mighty genius utters, without a thought of the intellectual philosophy which might bring one to the same conclusion. His most reflective mood in this play is doubtless reached in

> "There's a divinity that shapes our ends,
> Rough-hew them how we will."

Quoting at random from his plays we find him full of positive statements as to the power of mind over matter.

"None can cure their harms by wailing them."

"When remedies are past, the griefs are ended
By seeing the worst, which late on hopes depended.
To mourn a mischief that is past and gone
Is the next way to draw new mischief on."

"We, ignorant of ourselves,
Beg often our own harms, which the wise powers
Deny us for our good."

The "Tempest" is a play which reflects, as a whole, Shakespeare's perfect acquaintance with his true ego. Prospero stands for the personality of God or good developed in the mortal Shakespeare. The power of Prospero is only used for good. A storm is created—a shipwreck follows; and yet no harm comes. Instead of harm, wrongs are righted; hearts are lighted up with love; forgiveness is asked with perfect faith that it rejoices alike "him that gives and him that receives," and life and love seal an eternal Now with peace, and joy and rest. Then Shakespeare most timely and fittingly declares his work done:

"Now my charms are all o'erthrown,
And what strength I have's my own;
Which is most faint."

Emerson perfectly understood the true source of the power of the genius, and clearly and boldly declared it:

"This overestimate of the possibilities of Paul and Pericles, this underestimate of our own, comes from the neglect of the fact of an identical nature."

"A man's genius, the quality that differences him from every other, the susceptibility to one class of influences, the selection of what is fit for him, the rejection of what is unfit, determines for him the character of the Universe."

Emerson, however, in "The Over-Soul," is most complete in his wonderful revelation of the centre:

"All goes to show that the soul of man is not an organ, but animates and exercises all the organs; is not a function like the power of memory, of calculation, of comparison—

but uses these as hands and feet; is not a faculty, but a light; is not the intellect or the will, but the master of the intellect and the will; is the vast background of our being, in which they lie—an immensity that is not possessed and that cannot be possessed."

Henry More tells of the undivided union of the soul and God in

"But souls that of His own good life partake,
He loves as His own self; dear as his eye,
They are to Him. He'll never them forsake:
When they shall die, then God Himself shall die.
They live, they live in blest eternity."

Robert Holt, of London, in a little poem, most dantily tells the story as it came to him:

"We talk not of God in such phrases,
As hide or entangle the Truth;
Nor sing with the dreamer who praises
The sensuous visions of youth;
But humbly avow that we know not
The form of the Fountain of Light,
Whose brilliant, bright harmonies flow not
From aught that is subject to sight.
Yet our hope is eternal progression,
With charity fruitful in all,
For time never knew retrogression,
Nor God e'en a thought could recall.
But o'er us, around us, and in us,
Abideth the Giver of Might,
Who tenderly teaching would win us
To trust that the true is the right.
So sink we to slumber unfearing,
Assured that our Father is nigh,
And wake up in the morning revering,
Or sleep on, unquestioning why."

These quotations from geniuses tell us that all of them recognized a higher power than intellect. Some of them hint at the way of approach to the centre; but, as a rule, they are more or less vague on that subject. The poet can hardly be expected to be didactic. When he nears that plane the intellect is guiding his pen; when he feels his best and greatest thoughts he writes from the seat of the emotions. These have little to do with logic, they have all to do with

the soul. The new metaphysics of to-day is founded on the bold proposition that all can learn how to reach this centre. These scientists tell us that when Christ said "I am the truth and the life," the "I" did not mean his personality. It meant the true "ego." Each one of us possesses it. It is as potent with us to-day as it was with the great teacher, did we only know. To learn, to know, will come to him who first appreciates the truths of the great philosophy, and then devotes himself to patient and indefatigable study of the laws that relate to the calling forth of the powers of the soul. These laws are pregnant with truth, and step by step is taken with full demonstration. Great freedom is allowed, as thought progress cannot run on absolutely parallel lines; still, there is a harmonious blending of experiences as each advances in the knowledge of Being.

He who seriously desires any worthy attainment can gain it, if he unites that desire with perfect faith that the good he wishes will come to him. Once he grasps the full power of the ego within him, he will know that desire implies in itself the power to reach and satiate it. The genius must, therefore, first have desired what afterward became his. With desire followed expectation, which enlarged into belief, struck the soul-centre dynamo, and then knowledge asserted itself, and the genius was born.

XUM

TOUCH.

By John Hitz.

"Sensitive power is not in actuality, but in potentiality; it does not perceive itself." ARISTOTLE.

"All of the senses are but modifications of touch," says Wallace,[1] and one of the latest definitions[2] states: "The sense of touch is the fundamental and least specialized or localized of the senses," whilst one of the most profound philosophers[3] of the last century declared: "The sense of touch gives substance and reality to all of our sensations, and its scope of action entitles it to be called: *The Universal Sense.*"

The manifestations of the sense of touch are generally classified into: 1st, Tactile; 2d, Pressure; 3d, Muscular.[4] Every tactile manifestation, of course, implies some form of contact, and to a certain extent *pressure*, but the sensation of the latter in its ultimate effect is altogether different from that of the mere tactile or intermittent surface-form. And then again, the tactile sensation, it is claimed, is entirely absent when the sense of touch manifests itself in the *muscular* form upon internal serous or mucous surfaces and substances. In its tactile form it is generally accepted to be the means through which mechanical force is appreciated, and this to a nicety, according to Preyer,[5] of one two-thousandths part of a gramme upon certain portions of the surface of the face, which he holds to be even more sensitive than the points of the fingers, although these with the blind we know attain an inconceivable delicacy of sensation.

[1] Epicureanism, p. 96.

[2] Century Dict.

[3] Swedenborg.

[4] Pain and Pleasure, included by some authorities, are omitted here, because it is held that these sensations belong more properly to psychophysical phenomena than to purely sensory manifestation.

[5] Die fünf Sinne des Menschen, p. 28.

It would be very interesting to tell about the functions of the wonderfully constructed *end bulbs* of Krause, the *touch corpuscles* of Wagner and Meissner, and the *corpuscles* of Vater and Pacine, but this must be reserved for another time.

Anatomy, we know, teaches that all nerve fibres *descend from* the brain through the neck into the body. We are furthermore shown that the substances which proceed from the brain into the spinal column are twofold, known as cortical and medullary, the cortical substance consisting of innumerable gland-like forms and the medullary substance of innumerable fibre-like forms. These, gradually bundling themselves together, constitute the nerves, which descend to the organs of sense in the face and to the organs of sense in the body; in fact, this medullary or fibrillary substance, wherever it presents itself, proceeds from the above indicated cortical or glandular substance which constitutes the surface of the *cerebrum*, and also that of the *corpora striata* from which proceeds the medulla oblongata; it also constitutes the middle of the *cerebellum* and the middle of the spinal marrow.

Now, "where fibres are in their first principles, there it is that life exercises its first or initial activity." [1]

Realizing, then, the intricacy of the substance in which sensation of all kind has its source or first principles, we can appreciate more fully the claim of universality made for touch—that it is not simply a mechanical pressure upon the surface of the body, but can manifest itself both consciously and unconsciously also in every action of the internal organs of the body. Just as we do not see force, but experience its effects, so we do not see action or motion, but only feel or experience it in the sensories every time it operates—regardless whether the operation is voluntary or involuntary. Now the special phase of touch to which I would invite attention at present is that of invisible *muscular sensation*, and in this connection would emphasize the fact that every muscle consists of fascicles of fibres, which emanate from the very source

[1] Divine Love and Wisdom, 366.

of life and respond directly to the will power, of which it is said,[1] "The will cannot only excite and check contractions, but is able to regulate their force and duration with wonderful precision, for by the muscular sense (the form or phase of touch we are now more particularly treating of) the mind is able to appreciate the state of contraction of a muscle by impressions originating in the nerves supplied to its fibres. The perfection to which habit, in numerous instances, brings the sense of touch, is chiefly due to an improved capacity it confers of appreciating the impressions made on the organ in connection with niceties of muscular movement." Touch, therefore, operates as a localizing sense by means of which the mind may refer any sensation to tactile points *within* or upon the surface of the human body.

Furthermore, its close relation to hearing (the last of the senses to develop after birth, while touch is the first) will be realized when the vibratory character of sound is considered. Vibrations, whilst being appreciable by the ear, at the same time are appreciable by touch. Both senses find their unity in that class of vibrations which have sound as one of their effects, and hence the exercise of touch can be availed of as the nearest intuitive approach to hearing which exists. Its functional capacity, therefore, in all forms of vocalization, including speech, is almost coequal to that of hearing. More especially in the matter of effectuating or producing tone in the larynx and palate the muscular sensation involved in speech is of paramount importance, and in this instance this phase of touch virtually graduates the requisite force of muscular impulse supplied by the brain through the nerves.

It is owing largely, if not altogether, to this muscular sensation, which can and does operate at times independently of any so-called auditory organ, that it is possible for the deaf to appreciate elocutionary efforts, and this imparts to language, when silently read, the actualness of audibly modulated speech. By this means it is rendered possible for a musician inaudibly to experience melody and harmony before these have ever been presented to his organs of audition. In

[1] Todd & Bowman, Physiological Anatomy, Vol. I, pp. 190, 428.

fact, it is this muscular sensation, says Ulrici,[1] that renders "all speech and music possible."

The most delicate and decisive actions of the organs of speech, such as the closing of the glottis, the vibration of the vocal cords, the elevation of the soft palate, etc., are all invisible, and hence afford no optical presentation of their auditory function and character, and yet practice and habit render them cognizable in the art of teaching the deaf to speak, to an extent which it is wonderful to observe.

We are told to observe the infant in its first efforts to articulate sounds—how its little tongue takes every imaginable position, before innumerable efforts and repetitions cause it to become cognizant of some certain position which enables it to produce a given sound. It is asserted that the muscular sense of touch contributes quite as much to this final satisfactory result as does the sense of hearing; in fact, it is claimed that neither the sense of hearing nor sight is essential in attaining the result, because in case of the deaf and blind the same result has been achieved by intelligent and persistent practice. It is true that in the case of the deaf and blind the auxiliary form of exterior touch is availed of to a certain extent, where it can be done, in verifying the utterance of a given sound—as, for instance, in differentiating syllables such as *keys* and *geese*. The ability to modulate the voice at will in diverse instances has been achieved by persons both deaf and blind, and this, it is claimed, is solely due to success in perfecting this so-called muscular manifestation of touch.

Dr. Thomas Arnold[2] tells us of "Antonio Provolo (1829), who constructed an instrument he called an *armonico*, made of seven pieces of steel of graduated lengths in the form of tongues, with a handle of the same material. These struck successively above a table would necessarily make, on whoever held it, an impression gradually stronger in proportion to the piece struck." Then Provolo made the deaf mute place his hand on his chest and articulate a vowel sound

[1] Gott und der Mensch, P. I, p. 301.

[2] Education of Deaf Mutes, Vol. II, pp. 267–68.

according to the seven notes of music, making the pupil observe the different impressions which were communicated from the chest to the hand accordingly as the vowel was pronounced higher or lower, and succeeded by degrees in making him imitate that scale, and thus by successive readings at last led him to sing. Although the singing was inferior, it enabled Provolo to modulate the voice of the deaf mute. The value of this method did not consist so much in teaching deaf mutes to sing, as in the demonstration of the possibility of leading them to vary the voice according to the relative pitch of the vowel sounds. Whatever may be its value in relation to speech, all singers know that glottal action in singing differs essentially from that in speaking. The vocal chords in speaking are lax or taut, according to the position of the whole organ; in fact, they may be said to depend on these positions and accommodate themselves to them; but in singing the voice rules and the organs follow so that the vowel sounds are on every variety of pitch; and we are also conscious of the introduction of a peculiar muscular action of the glottis by which it is held to the positions required by the pitch. These registers are well known to vocalists, whereas in speaking they hardly find a place. It would seem, however, that an instrument constructed like Provolo's, whose vibrations could be well felt, must assist the learner in giving the right pitch to the vowel sounds.

Arnold, furthermore, illustrates the important part which muscular sense takes in teaching speech to the deaf when he cites the case of a musician: "Any one who would learn to perform on flute or piano begins by placing his fingers on the vents or keys. This is a slow process, requiring much attention to the muscular adjustment of the hands, but, once mastered, performance begins. Here habit has little power, for he still finds it difficult to shift his hands and fingers to varied positions. Thoughtful attention precedes every movement. Sight, touch and muscular force render their aid till by frequent repetitions facility grows. * * * * Whether we call it habit or reflex action, sensory activity increases by use, and muscular action takes its place at the required points

till a general consent is effected and all seems self-actuated." Yet all this is not so much automatic or reflex as the gradual development of mental control over its physical agents. Let attention be withdrawn in performing the most familiar pieces and a sudden arrest follows.

Now, a deaf child learning to speak is a musician, and its organs of speech are the instrument. At first it is as difficult for the child as for the musician. The placing of the tongue, of the jaw and the lips, is all new, and requires thoughtful attention. But where the child is only deaf it has eyes to see and fingers to feel, while touch is everywhere present in finding the points of organic contact or position. The instrument is in fact part of himself, and hence possesses a vitality that never can be conveyed to wood or wire, and, therefore, the impressions of former sensations remain to facilitate repetition. The law of habit speedily shows to the child its presence, so that if half the time and toil given to learn a few tunes on a piano were given to teach him to speak, the success would astonish. Yes, the time would come when the speech would seem automatic, or very much indebted to reflex action. An equally good illustration of the scope of the service which the sense of touch renders, is that given by Dr. A. Graham Bell in speaking of the so-called glove alphabet recommended by George Dalgarno (b. 1627). This, it is true, is a method which more properly should be classed with visible tactile manifestations of touch; nevertheless, as it can be availed of by such as are bereft of both sight and hearing, it well serves to illustrate what can be achieved by a proper study and utilization of the muscular sense. The Dalgarno method consists in arranging the letters of the alphabet upon the inner or palm face of a glove.

The deaf person puts this glove, say, upon the left-hand, and then the speaker with the fingers of his right-hand touches the various letters in the order of spelling words. It will require but a brief practice before the deaf and the speaking person can dispense with the glove altogether. Dr. Bell states, in referring to his application of this method in

connection with the instruction of a deaf lad he undertook to teach :[1]

"In communicating with me it was unnecessary for him to wear the glove, as we both remembered the places of the letters. * * * * * I took his hand in mine and touched the places of the letters upon his hand. As I had five fingers, I could touch five letters simultaneously, if I so desired, and a little practice enabled me to play upon his hand as one would play upon the keys of a piano, and quite as rapidly. I could also give emphasis by pressure upon the fingers, and group the words together as they would be grouped in utterances, leaving pauses here and there corresponding to the pauses made in actual speech. The more I used with him this communication, the more I rejoiced in the fact that I had decided to employ an alphabet addressed to the sense of touch instead of sight."

Since, however, we have graphically presented to us the *mechanical* action of the organs of speech in that indispensable achievement of phonological science, VISIBLE SPEECH, the teaching of speech to the deaf can be conducted upon well-established scientific principles in such a manner as to enable the pupil to definitely analyze the mechanism of any sound, and to impress it firmly upon his mind for reproduction, by means of symbols covering the entire range of sounds embraced in the language of any nationality whatever. The author and inventor of "Visible Speech" clearly aimed to find a *physiological* instead of a linguistic basis for the classification of the sounds used in the vocalized languages of mankind. He distinctly states: [2]

"Visible speech is a system of symbols which exhibit all the visible and *invisible* positions of the organs in forming speech—it is a revelation and a record." He further definitely states: "Vowels are SHAPES—consonants are GRIPS of the mouth. Vowels have fixed shapes, with open apertures; consonants have transitional shapes with closing or opening

[1] American Annals of the Deaf, Vol. XXVIII, pp. 134–5.

[2] Prof. A. Melville Bell, "Speech Reading and Articulation Teaching," p. 27, *ib.* p. 12.

movement of the organs. All consonant movements may be made either with or without accompanying voice." This well-defined physiological basis for a cognizable or visible presentation of the mechanical movement of the organs of speech, whether audible or inaudible, would seem clearly to establish the fact that the muscular sense or phase of touch is a conscious and most important factor brought into requisition in the act of speaking, and that by proper and persistent training of this phase of touch a gifted, although totally deaf, person can attain well nigh, if not wholly, as perfect voluntary (and eventually spontaneous) control of these organs as would be the case of one whose hearing is unimpaired. And it is asserted by prominent German teachers of the deaf[1] that so long as a pupil does not readily detect his defects in articulation—when attention is called to them—and apply the proper corrective, this sense of touch has not been properly or adequately trained; and furthermore it is largely owing to neglect of this particular point that the deaf so frequently articulate without any assured consciousness; in fact, owing to this uncertainty, frequently dislike to articulate.

Dr. Herman Gutzmann, the eminent specialist, says,[2] "The fact is overlooked by many that the deaf mute in the perception of what is spoken is not only served by the sense of sight, but also by the muscular sense. It is muscular touch which localizes the positions and actions of his organs of articulation when he converses with others. He, therefore, in fact (consciously) also speaks to himself. * * * It is surprising that the exceptionally distinct and clear statements of Kussmaul upon this subject are so persistently ignored."

Prof. Albert Gutzmann,[3] in speaking of the treatment for stammering, lays special stress upon the fact that muscular action should not be merely mechanical, but result from conscious mental effort; that in the treatment for stammering

[1] Paul Rieman in No. 22, Vol. VII, "Blätter für Taubstummen Bildung."

[2] "Medezinisch Pädagogische Monatsschrift für die Gesammte Sprachheilkunde," Vol. I, p. 229.

[3] *Ib.*, p. 363.

the central seat of the defect is assailed, and the muscular organs requisite for speech are exercised in a physiologically conscious manner. To this end a preliminary exercise of the muscles involved in producing tone is resorted to, which effect in one breath the transition from voiceless exhalation to whispering, and finally to distinctly audible vowels. The value of proceeding thus, Prof. Gutzmann says, lies in the fact that the tone-producing muscles are thus brought *successively*, instead of *simultaneously*, into action. This invisible action can then, if desired, be also verified by tactile touch of the fingers upon the exterior surface of the throat. In conclusion, Prof. Gutzmann in substance declares, "If you would exercise the muscles involved in producing speech with a view to effect an improvement of utterance, this can only be achieved by a physiologically conscious action of the muscles."

The more clearly man comes to realize the fact that the muscular sensation of touch is really appreciable and subject to his will power, the more readily will he devise means whereby to avail himself of this important aid in giving adequate effect to his articulate utterances.

These recent efforts of educators to give to touch, the "first born" of the five senses, consideration and thought commensurate with its scope of service as a willing handmaid and frequent substitute for its colleagues, are fully sustained by some of the most eminent savants of the day, one of whom asserts in a recent publication,[1] "The sense of touch alone can suffice for a full development of the germs which exist potentially in the human mind. This is a *datum* of great value to science."

[1] Prof. Ernest Naville, "Helen Keller L'Education d'une Jeune Fille Aveugle, Sourde et Muette, par R. Glena," pp. 7–8, 1894.

XUM

THE OPEN COURT.

Comments on Articles in Previous Numbers of the Review.

MENTAL TELEGRAPHY OR—INSTINCT?

The contributor to the July number of the NEW SCIENCE REVIEW of an interesting article termed "Mental Telegraphy," would seem to the "logical skeptic" (to whom she (?) refers), to have leaped blindly after Mark Twain over the wall of speculation without first inspecting the ground on the other side.

She feels struggling within her, for liberty, a power to "which time and space and absence mean naught when this power is understood" (sic)—a power one would think that it were well to keep under control; but she frankly acknowledges that *she* does *not* understand it. Nevertheless she believes it to be a good sort of thing to have, though she complacently declares that its presence is as rare as the gift for music or for painting. This assertion, however satisfactory to her, would be disappointing to her readers, did it not appear that rather than having discovered a new sense, she has "reverted to type," so to speak.

Under the influence of this power she has had some very commonplace, it would appear "to the thoughtless," but to her remarkable experiences. She gazes at a photograph of a "man's head," is overcome with the sense of having known the subject, and makes inquiries which result in her discovery of his identity; she is thereupon filled with amazement that she should be more affected by the face than stirred to the depths of her "inner consciousness" at the sound of his name, which means nothing to her. Eight years elapse, when in a theatre she again experiences that feeling of "having known," and turning her head discovers that this man is staring at her. She then cuts off the circuit, and falls to cudgeling her brain for some occult reason for the presence of the man at the theatre, though, perhaps, any but a mental telegraphic operator would promptly jump to the conclusion that he had come "to see the show!" She does *not* inquire from the owner of the photograph though as to whether this man had been informed of her evident interest in him.

She then relates of how she would sit down and write notes to a friend from whom she would be separated for whole days; but she would hardly have time to blot these effusions before this friend would materialize, so at last she tried to fool her by tearing up the notes as soon as she had written them.

This did not answer either, though "the thought would have the desired effect," and as "several miles" divided them one

would suppose that her friend's must have been rather a disturbed existence.

"The sight of a certain handwriting would always make my heart sink." Ah, how often we have all experienced this phenomenon, especially the more impecunious of us!

And then the possessor of this mental telegraphic system "grounds" her wire with these words: "One dark day I found that my *instinct* was right," and, to the skeptic, involuntarily solves the whole difficulty.

My dog takes an immediate liking to some people, and displays a strong sense of "having known;" for others he expresses his distaste by equally strong demonstrations, yet I have never supposed that this was anything more than mere instinct. I can take him a dozen miles from home by rail, and without even writing him a note can feel tolerably certain that he will return inside of twenty-four hours over an entirely unknown road; still I don't imagine for a moment that he is at all conversant with the art of mental telegraphy.

Once I lost my way on the prairie; I was nearly starved, and was suffering tortures from thirst. Finally, in despair, I threw the reins on my horse's neck and instantly he quickened his step and paced off in an entirely different direction from which I supposed my destination lay. After traveling for some hours, and that, too, after night had fallen, and in pitchy darkness, he brought up at a watering station on the railroad. I had not intended to visit this station, but I was glad to be there, for there were food and water to be obtained, and yet this was an entirely uneducated Western pony (genus "plug") whose mental development had been grossly neglected.

The whale and the boa constrictor have rudimentary hind legs, but they do not take the trouble to grow them, because they have already at their command more satisfactory means of locomotion; the fish found in the mammoth cave, having no further need of them, have discarded their eyes; so we, having learned to think and speak, suffer from atrophy of the instinct.

> "Reason raise o'er instinct as you can,
> In this 'tis God directs, in that 'tis man."

That we all have this rudimentary hind leg, or instinct, there is no possibility of doubt, but it would seem to be rather a serious question whether the development of it would not have to be made at the expense of such artificial accomplishments as reason and speech and thought. That in remote instances these gifts in their fullest development may be combined, my gallantry compels me to admit, believing, as I do, the author of "Mental Telegraphy" to be a lady. COCKBURN HARVEY.

SIXTY-FIFTH ANNUAL MEETING OF THE BRITISH ASSOCIATION.

Sir Douglas Galton, in his address at the formal opening, on September 12th, of the Annual Meeting of the British Association for the Advancement of Science, held at Ipswich this year, after touching upon the solution of various problems in the enormous strides made since 1831, when the Association was founded, in the investigation of facts elucidating the operations of the laws of nature, asked: "But what will our successors be discussing sixty years hence?"

After briefly considering our present knowledge in chemistry and astronomy, he claimed that the progress in physics had been equally marked. But, what, he asked, would our successors be discussing sixty years hence? How little did we yet know of the vibrations which communicate light and heat? Far as we had advanced in the application of electricity to the uses of life, we knew but little even yet of its real nature. We were only on the threshold of the knowledge of molecular action or of the constitution of the all-pervading ether. It was only within the last few years that we had begun to realize that electricity is closely connected with the vibrations which cause heat and light, and which seem to pervade all space—vibrations which may be termed the voice of the Creator calling to each atom and to each cell of protoplasm to fall into its ordained position, each as it were a musical note in the harmonious symphony which we call the Universe. The state of meteorological science was now such that few civilized countries, north or south of the Equator, were without a system of storm-warning, but vast as had been the advances in physiological botany since 1831, much of its fundamental principles still remained to be worked out. The labors of Cuvier and Richard Owen gave an impulse to biological science which was reflected through the early decades of the British Association until Darwin propounded his theory of evolution. Owen did not accept Darwin's theory, and a large section of the public contested it. He well remembered the storm it produced—a storm of praise by his geological colleagues who accepted the result of investigated facts, a storm of indignation such as that which would have burned Galileo at the stake from those who were not yet prepared to question the old authorities; but they diminished daily. They were, however, as yet only on the threshold of the doctrine of evolution. Did not each fresh investigation even into the embryonic stage of the simpler forms of life suggest fresh problems? The impulse given by Darwin to anthropological research had been fruitful in leading others to consider whether the same principle

of evolution may not have governed the moral as well as the material progress of the human race. Mr. Kidd had held that Nature, as interpreted by the struggle for life, contains no sanction for the moral progress of the individual, and he pointed out that if each of us was allowed by the conditions of life to follow his own inclinations, the average of each generation would distinctly deteriorate from that of the preceding one; but, because the law of life is ceaseless and inevitable struggle and competition, and ceaseless and inevitable selection and rejection, the result is necessarily ceaseless and inevitable progress. In considering the evolution of the human race, the science of preventive medicine might, the President thought, afford some indication of the direction in which to seek for social improvement. Preventive medicine required a knowledge of the details of the previous conditions of life and of occupation. Moreover, death was not our only or most dangerous enemy, and the main object of preventive medicine was to ward off disease. Disease of body lowered our useful energy. Disease of the body or of the mind might stamp its curse on succeeding generations. Mental actions were indicated by movements and their results. Such signs were capable of record, and modern physiology had shown that bodily movements correspond to action in nerve centres as surely as the motions of the telegraph indicator express the movements of the operator's hands in the distant office.

Sir Douglas closed his remarks with an expression of confidence that, as on every side we are surrounded by mysteries awaiting solution, he had full belief that the future records of the British Association would chronicle a still greater progress than that already achieved, and that the British nation would maintain its leading position amongst the nations of the world if it would energetically continue its voluntary efforts to promote research, supplemented by that additional help from the Government which ought never to be withheld when a clear case of scientific utility had been established.

XUM

REVIEWS.

A JOURNEY IN OTHER WORLDS, BY JOHN JACOB ASTOR. (D. Appleton & Co., New York.)

It may seem that a romance is not the kind of literary matter suitable for review in a science quarterly; but as Mr. Astor's interesting production has a most decided scientific bearing, it possesses a satisfactory claim to a place in our columns. Its science, of course, is fiction, and indicates a somewhat prolific imagination in the author; but the work is admirably performed, and bears a highly interesting realistic relation to true science, a fact which induces us to give it consideration here. The best way to do this, perhaps, is to present a brief outline of its contents.

In opening its pages we find ourselves suddenly whisked forward to the year 2000 A. D., and set down amid strange and striking results of scientific and mechanical evolution. Among the great schemes to which we are introduced is that of the "Terrestrial Axis Straightening Company," and that of a trio of daring adventurers who propose to leave the earth and explore the distant planets. For this purpose they have built an air-tight vessel, the Callisto, supplied abundantly with compressed oxygen and condensed food, whose motive force through space is to be a newly-discovered power called "Apergy," the reverse of gravitation. This repellant power is completely under control, and by alternating it with gravitation the planets can be receded from and approached at will.

We have no space to describe the journey of the adventurers from the earth outward. They pass Mars almost within touching distance, wind their way through the asteroids, and finally land on Jupiter, where their adventures are many and extraordinary. This great planet is found not to have reached the human stage of evolution. It is still in the age of reptiles, and many extraordinary creatures are seen and described, with much scientific verisimilitude. Among these is an elephantine ant, a six-legged "scissor jaw," whose mouth-power is equal to that of strong steel shears, and which makes havoc among the huge tenants of the Jovian wilds.

After escaping imminent perils, and experiencing strange adventures, the voyagers set sail through space again, and soon after made port at Saturn, avoiding its moons and rings, and landing on its surface. Here is found a decidedly different state of affairs. The animal and vegetable life of Saturn proves to be very different from, though no more advanced than, that of Jupiter; but this planet is found to be the abode of spirits, from whom the adventurers learn things of importance, and by whom they are warned against many dangers. The much-traveled trio finally return to the earth, which they reach again after a six months' absence.

Such is a rapid digest of the work in question. The ingenuity displayed in devising its many peculiar situations, and the scientific acumen manifested in its fictitious creations, are worthy of high praise, and Mr. Astor can be complimented on having achieved a decided success in the peculiar field he has chosen.

CANYONS OF THE COLORADO, BY J. W. POWELL, PH.D., LL.D. (Flood & Vincent, Meadville, Pa.—*The Chautauqua Century Press.*)

Professor Powell, member of the National Academy of Sciences, and until recently Director of the United States Geological Survey, has in this profusely illustrated and handsomely published work told the story of a famous exploit of his earlier days, in which he, *a one-armed man*, with a company of equally hardy and daring companions, boated down the Colorado river, traversing the whole length of its mighty canyon, a mile or more in vertical depth, and passing through perils of rapids and cataracts such as few men have dared and lived to tell the story.

Accounts of this remarkable exploit have long since been published, and are somewhat familiar to the scientific reader; but in the present work the story is given in fuller detail, and extended to cover the author's complete "Exploration of the Colorado River of the West, and its Tributaries, from 1869 to 1872." The publishers of this superb volume deserve great credit for the excellence of their work. As for the merit of the author's labors little need be said, the highly creditable character of Prof. Powell's literary and scientific work being too widely known to call for special commendation at our hands. The subject of the work is one of much importance and great interest, the Colorado river presenting a phenomenon of rock excavation which stands unrivaled upon the earth, running as it does at the bottom of a chasm, of its own making, from four thousand to seven thousand feet in vertical depth. In the work in question the interesting and peculiar features of this extraordinary rock excavation are fully described, while the numerous photographic reproductions with which it is illustrated almost tell the story in themselves.

PAN-GNOSTICISM: A SUGGESTION IN PHILOSOPHY, BY NOEL WINTER. (The Transatlantic Publishing Company, New York.)

The work above named seems to us much more than a "suggestion in philosophy." It is rather a plunge headlong into the ocean of philosophy, and we should warn all prospective readers of its pages that they will have very deep waters in which to swim. According to the author, everything can be known: "The conditions necessary to absolute mystery involve an absurdity; in fact, theoretically speaking, knowledge is possible of everything concerning which there is possibility of ignorance." As to how the author demonstrates this somewhat startling proposition the reader must learn for himself. The explication of it constitutes the whole work, and the work is like condensed meat, composed of spacious thoughts compressed into very small bulk. The nature and relations of consciousness, its dealings with phenomena, and

the philosophy of phenomena considered in themselves, form the staple of the argument, which is very ingeniously and intricately developed. The outcome of it all is a doctrine which the author entitles "Pan-Gnosticism," as covering the totality of knowledge. It teaches that, "Every question properly so-called is, *in its nature*, answerable; that, when a sensible question is *not* answerable, it is only relatively or practically so; it not being possible to frame a question, having sensible meaning, which would be absolutely or theoretically unanswerable." This does not apply to ultimate facts, since to those the question of knowability is not applicable.

CHEIRO'S LANGUAGE OF THE HAND, BY "CHEIRO." (The Transatlantic Publishing Company, New York.)

We have here the third edition, revised and enlarged, of a highly popular work, the production of the well-known expert in palmistry, "Cheiro the Palmist," and giving practical exemplification of the interesting sciences of Cheirognomy and Cheiromancy, which for thousands of years have attracted the attention of mankind. The practice of palmistry is traced back by the author to a very distant epoch in the history of mankind, and shown to have been extant in India at a very remote period. From India it spread to other civilized lands, flourishing particularly in Greece, from which classic soil it was transmitted directly to the modern world.

The work in question is a complete and lucid explication of this curious topic, which is at present attracting so much attention. In addition to a thorough description of the formation and characteristics of the hand, and of its various significant lines, it presents over two hundred engravings of "lines, mounts and marks," and forty full page illustrations. The latter are a special and highly valuable feature of the work, since they include exact reproductions of the hands of many famous people—Sarah Bernhardt, Mark Twain, Robert G. Ingersoll, Mrs. Frank Leslie, W. T. Stead, Annie Besant, Sir Frederick Leighton, Sir John Lubbock, Sir Edwin Arnold, Rev. C. H. Parkhurst, Hon. Joseph Chamberlain, the Lord Chief Justice of England, and various other notable characters.

Cheiromancy is being practiced by many persons at the present day, and stories are told of their power in reading character, and even in predicting future events, from a study of the lines of the hand, which are, to say the least, remarkable. It is no easy matter to believe that the story of a man's life and character can lie concealed in the lines and marks that cross his palm, yet many intelligent people believe such to be the case, and are prepared to sustain their belief by startling experiences of their own and others. As for Cheiro himself, his powers in this direction are claimed to be wonderful, and the work contains, in an appendix, attestations of his strange powers from many prominent persons, the first of which, from the Duke of Newcastle, we quote: "Cheiro has told my past and immediate future with wonderful accuracy, especially with regard to certain coming events which he could not possibly have known."